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BRITISH AGRICULTURAL POLICY

A. N. SKELTON, M.P.
Parliamentary Under Secretary of State for Scotland

FOR all who care for Scottish agriculture the year just past and the one we are entering are likely to prove the most notable of our time.

The year 1932 has seen the conditions under which the farmer carries on his industry completely revolutionised. "Free Trade" has disappeared. In its place stands a system in which protective duties, guaranteed prices, and restriction of imports all play their part. When that system is in full working order it will give the farmer a security and a confidence he has not known for many a long day. But the year in which this great Revolution has been carried through has brought with it such a disastrous fall in world prices that the farmer is inclined to think that help is coming to him too slowly. He does not, perhaps, fully appreciate the vast importance of what has been accomplished, because it has not afforded him immediate and complete relief. Yet 1932 ended with a voluntary restriction of the importation of beef, mutton, and bacon, which is already beginning beneficially to affect the price of the home produce; with 13s. 6d. a quarter, over and above the price received in the market, handed over as an interim payment to the registered wheat-grower of Scotland and England; with an import duty of £1 a ton on main crop potatoes coming in from abroad, and of £4, 13s. 4d. on early "luxury" potatoes, to say nothing of the ordinary revenue duties on barley and oats, on eggs, on fresh milk and sweetened condensed milk, and the somewhat heavier duties which, under the Ottawa agreements, have been imposed on foreign butter and cheese. Truly a remarkable change in a twelvemonth.

So much for 1932. What of the year ahead of us ? As far as Government action is concerned, two major steps remain to be taken : first, permanent arrangements for the restriction of beef and mutton imports, for which a Conference meets in London in the summer ; second, the elaboration of a scheme for the development of the bacon industry in this country, to which the report of the Lane-Fox Commission has shown the way. These things accomplished, the main immediate work of the State for agriculture will have been done.

State action indeed has filled the stage in 1932. In 1933 the producer himself will take a hand in the game. For during the year the farmers of Scotland will, almost certainly, be called upon to give their decision on marketing schemes for beef and mutton, for milk, for potatoes. In all such schemes the last word lies with the producers themselves. Will they approve or reject them ? Will 1933 see a real beginning of organised marketing, just as 1932 saw the end of unrestricted foreign imports ? This is for the producers alone to decide. The Government, Parliament, the politicians, the Press cannot affect their action. It is a great responsibility and a great opportunity. To come to a right decision will require much deep and careful thought. For this reason, at the very outset of the year, I venture to call attention to the vital matter ahead. The great question for 1933 is : How will the agriculturists decide—against organised marketing or for it ?

a. n. Skelton.

PLANNING AND WORLD MARKETS[1]

E. M. H. LLOYD

Assistant Secretary, Empire Marketing Board

IT has often been observed that the chief issue before the modern world is to make up its mind not so much between two rival systems of collectivism and individualism, but as to the exact degree to which collective planning and State control should be grafted upon freedom and *laisser-faire.* Sir Josiah Stamp, in a recent address to the Academy of Political Science of New York, entitled "Control or Fate in Economic Affairs," has pointed out that we are all of us occupied in finding some position for ourselves between the two extremes of uncontrolled individualism and *laisser-faire* on the one hand, and the complete manipulation of the life of the individual as it is being attempted in Soviet Russia to-day. "Some of us would have a central control of stocks of commodities. Others would have a central or international control of the value of gold. But whatever our interest may be, it is almost a platitude to say that we are all planning to-day at some point or other along that line."

My object in this paper is to discuss planning or artificial regulation as applied to the marketing of agricultural products in world markets.

The world is puzzled and distressed by the paradox of hardship and want in the midst of plenty. The advocates of control urge better organisation, rationalisation, and planning. Leaving matters to drift and take care of themselves has been tried too long with disastrous results. Let us step in and do a bit of conscious planning. To parody the well-known song :

We don't want to Plan,
  But, by Jingo, if we do—
We've got the farms,
  We've got the men,
We've got the money too—
  (Plenty of it, lying idle in the banks).

That is one school of thought. The other school is profoundly sceptical of all artificial measures of interference and control. It holds that ill-advised attempts of Governments, pools and combines to fight against natural economic laws have proved disastrous : that they were largely responsible for the crisis, and that their continuance and extension serve merely to intensify it.

This is the fundamental issue that underlies any discussion of the Distribution of Agricultural Products.

For fifty years or more scientific research and mechanical invention have been improving agricultural technique and enormously raising productive capacity. We are no longer faced with the danger of food shortage. On the contrary, our chief trouble is the existence of unmanageable surpluses. Is scientific research then responsible for the trouble by teaching farmers to produce too much ? Or is it possible that we have not paid sufficient attention to the problems of distribution and marketing ? Should not scientific planning and guidance of productive processes have its counterpart in scientific planning and guidance of marketing and distribution ?

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[1] An Address delivered to Section M (Agriculture) of the British Association for the Advancement of Science at York, 6th September 1932.

My answer is a cautious affirmative, but I lay emphasis on the word " scientific." If we are to have planning, let us learn from experience, and subject our schemes to a constant criticism and analysis in the light of observed facts. Let us, in short, adopt the scientific spirit, and recognise that before we can control phenomena we must be able to recognise and measure the relevant data.

First, as to these surpluses. It is sometimes implied that scientific research has resulted in an over-production of agricultural products beyond the world's capacity to absorb. This is one of those half-truths which may be dangerously misleading. Apart from the question whether there has, in fact, been such a rapid advance in agricultural technique in recent years, there are surprisingly few instances of abnormal increases in world agricultural production. There has certainly been over-production in relation to effective demand or consumers' incomes, but there is little or no evidence of any general over-production compared with the statistical trend of previous years. Indeed, in a striking paper read to the Academy of Political Science in April 1931, Dr Carl Snyder, of the Federal Reserve Bank of New York, shows that world production of foodstuffs and raw materials, though it increased rapidly after the set-back of the war, had not yet reached, in 1929, the continuation of the pre-war trend. The statistics suggest that world agricultural production is, in fact, less now than it would have been but for the war.

The troubles of agriculture are not due to scientific research or mainly to any abnormal increase of production. The agricultural crisis is due to the fall of prices ; and this fall of prices is due more to diminution of effective demand through a contraction of consumers' money incomes than to any exceptional increase of supply.

It would be more true to say, therefore, that while with the aid of science the world has gone far towards solving the problems of production, it has not yet succeeded in solving the problems of distribution.

The problem of distribution in its widest aspect involves the working of the monetary system, the mechanism of investment, the relation of savings to consumption, and the division of profits and wages. These problems raise questions of commercial and financial policy and social and political issues which are outside the scope of this paper. But it is worth emphasising, first, that we cannot expect the world's agricultural depression to be solved by measures confined to agriculture ; and secondly, that the clearest and most urgent field for world planning at the present time is probably to be found in the working of the gold standard and the control of credit by the Central Banks. The success of artificial schemes for regulating the marketing of agricultural products depends more than is commonly recognised by their authors on stability in the value of money and the maintenance of better equilibrium between prices, wages, and debts. In the absence of monetary planning, attempts to control prices of particular commodities are like stopping up holes in a sieve.

In the narrower sense, with which we are now concerned, distribution means the marketing of commodities. With some primary products, particularly the scarcer minerals, distribution is in the hands of a few large concerns which have more or less definite understandings and agreements designed to control production, fix prices, and delimit markets. In others, as in wool, there are scores of thousands of independent units producing and marketing the commodity under conditions of untrammelled competition. Which is the better system to adopt ? And what should be the attitude of Governments ? Should they pass laws prohibiting combination and restraint of trade? Or should they discourage competition and even make it a statutory offence to produce and sell without a permit from a central body ?

On July 22nd last a statement of policy was adopted by the annual general meeting at Lausanne of the International Commission of Agriculture, which claims to represent the combined views of national agricultural bodies in many countries. It begins :

> " The general assembly considers that a judicious organisation of production and exchange will constitute one of the most effective means for fighting the agricultural crisis and establishing the prosperity of nations on a new basis. The first step would be to substitute orderly marketing, through the agency of associated bodies or by means of systematic State-controlled quota import arrangements, for the present unregulated offers of large quantities on world markets."

The statement then goes on to advocate international quota arrangements for cereals, sugar, wine, and other commodities.

The remarkable point about this statement is the emphasis it lays on orderly marketing and State control of imports and exports by means of quota arrangements. Farmers have in the past been stubbornly individualistic and jealous of their freedom. Is this new-found zeal for regulation and State interference merely a gesture of despair born of the economic crisis, or does it represent permanent conversion to the principles of planning and control ?

No simple answer is yet possible. All we can perhaps venture to predict is that schemes that work well will survive ; others will fail and be abandoned. The conditions of success or failure vary so much with each commodity that experience is worth more than theory in determining the precise mixture of freedom and regulation which works best. Planning and regulation that work well are to be welcomed as an improvement on the harsh and often wasteful ruthlessness of unrestricted competition; but bad planning may be, and often is, far worse than no planning at all. Indeed, the chief objection to all forms of artificial interference with economic forces is that it is so much easier to plan badly and make mistakes than to plan well and achieve permanent success.

Can we then attempt to lay down any general propositions as to the conditions of successful planning in the distribution of agricultural products ?

First, let us be clear as to the scope and object of the plan. In whose interest and by what standard is its success or failure to be judged ? It is tempting, especially in a crisis like the present, to consider only the producers' interests and ignore the consumers ; and indeed it is simpler and far commoner in practice to consider only the interests of particular groups of producers.

But artificial schemes of a sectional and national kind must be judged by their effects on the general welfare as well as on that of the privileged groups. We may find, for example, that the exceptionally low price of wheat, which has caused a severe contraction in the demand of oversea wheat-growers for the products of European industry, is to a large extent due to artificial measures designed to raise wheat prices in European countries. The great danger of sectional and national schemes to bolster up the position of privileged groups is their boomerang effect on other classes of the community both inside and outside the national frontiers. The action of Governments is generally confined to schemes designed to assist producers within their national frontiers.. Clearly, if a law could be passed requiring all the bread consumed in York to be made out of wheat grown in Yorkshire, or a duty of 100 per cent. were to be imposed on all wheat crossing the county boundary, it would assist the Yorkshire wheat-growers but would not be in the general interest of the town or of the rest of the country. Such a plan would be regarded by most people as an example of bad planning. We may find, on the other hand, that there are cases where some restriction on competition may be in the interests not only of producers, but also of consumers, or at least not seriously prejudicial to consumers. As examples, one might take the control of Brazilian coffee or the regulation of meat shipments from the Argentine and New Zealand.

The aim of a good plan should be to promote a more satisfactory adjustment of supply and demand than *laisser-faire* can bring about, to avoid gluts and shortages, and to smooth out the sharp fluctuations in prices which unrestricted competition may cause. One of the mistakes made under the Stevenson Rubber Restriction Scheme was to overdo restriction. Prices were raised or allowed to rise to an extent which gave excessive profits for a short period, but encouraged an increase of production elsewhere. This temptation or tendency to use the instrument of control to keep prices too high has brought many schemes to grief.

As a safe working rule it might be suggested that a sound plan aims at securing for the producers no more than the average over a given period of time of the prices he would have obtained under *laisser-faire.* This is an elusive criterion which may be difficult to interpret at any given moment, more especially in times of great monetary instability. It is better perhaps to express it in the negative. Any scheme which seeks as a permanent policy to raise prices above their economic level—in other words, to secure a remunerative price for all producers, including the high-cost marginal producers—is not only dangerous and difficult but contrary to the general interest.

One of the most essential conditions of successful planning is reliable statistics. The Russians are having bitter experience of this in the application of the Five Year Plan to agriculture. The reliability of Russian agricultural statistics depends ultimately upon information obtained from millions of illiterate peasants and transmitted by thousands of local officials. The possibilities of error are evidently great, and have led to serious miscalculations by the central authorities of the probable future production of grain and meat.

The inadequacy of private forecasts, and the undesirable results of market fluctuations caused by inaccurate rumours, have led to a rapid extension of the collection and publication of statistics of production and forecasts by central bodies, for the most part government agricultural departments. It would not be altogether fanciful to suggest that this development of organised market intelligence, while it undoubtedly contributes to the smoother working of *laisser-faire,* is in fact the beginning of a transition to planning and the dethronement of *laisser-faire.* It, at any rate, renders planning possible.

At the outset published statistics begin to influence the operations of buyers and sellers, and prices reflect more accurately the true statistical relation of supply and demand. It is natural that at this stage attempts to work out a conscious marketing policy should be made by powerful groups of buyers or sellers. In the case of producers this leads to schemes for regulating either the volume of supply, or at least the flow of supply. It involves a deliberate attempt to adjust supplies to what the market will absorb at a price-level satisfactory to the producers. This brings us straight into the region of artificial planning.

Experience suggests, however, that most schemes fail or fall short of their goal through errors and miscalculations based upon imperfect knowledge of all the relevant data. This central difficulty applies, of course, to industrial planning as well as to agriculture. The production and marketing of industrial products are, as a rule, more amenable to control than agricultural products; but even industrial cartels, which achieve a fair measure of success in controlling production and marketing in normal times, are seldom immune from serious trouble in a period of world-wide monetary disturbances. In the absence of monetary stability, statistics and market intelligence confined to one particular commodity may prove a wholly unsafe guide; and even in normal times fluctuations in demand are difficult to measure and still more difficult to forecast.

The complexities of the problem may be illustrated by a brief summary of some recent schemes of artificial regulation.

(1) **Rubber.**—The case for some central scheme to adjust the supply and demand for rubber is a particularly strong one. A rubber tree takes five or six years to come into bearing and some ten years to come to maturity. The rapid expansion of the motor-car industry after the war led to high prices and profits which stimulated excessive planting. As the new trees came into bearing demand failed to keep pace, and during the present slump the production of motor cars in the United States fell by 55 per cent., from 5,360,000 in 1929 to 2,390,000 in 1931. The price of rubber, after touching a high point of 4s. 6d. per lb. in 1925, dropped from 10d. at the end of 1929 to below 2d. in June 1932. The Stevenson restriction scheme failed mainly because it was confined to British territory and did not cover the Dutch East Indies, but partly also because mistaken forecasts led to the price being raised too high. Attempts to bring in the Dutch East Indies have hitherto failed owing to the extreme difficulty of controlling either the production or the export of native-produced rubber in Sumatra. A formidable problem is presented at the present time by the existence of stocks more than double the normal. Ideally what seems to be required is a central stock-holding scheme under which the surplus stocks would be lifted off the market and strongly held as a reserve for gradual liquidation over a period of years. The principal objects of any such scheme should be, first, to prevent too drastic a decrease in production through the wholesale bankruptcy of producers; and secondly, to check a too rapid increase in price leading to excessive planting when demand once more overtakes supply. Indeed the chief evil to be avoided in the rubber industry is excessively high prices, which lead, after a spasm of hectic speculation and over-capitalisation, to over-production, low prices, and bankruptcy. Owing to the technical difficulties of controlling production and new planting and the uncertainty of future demand, regulated stock-holding seems to hold out the best hope of avoiding extreme maladjustment of supply and demand; but the financial and other risks of any such scheme are exceedingly formidable.

(2) **Coffee.**—The Brazilian Coffee Valorisation scheme has interesting points of similarity and contrast to that of Rubber Restriction. The demand for coffee is less subject to rapid changes

than that for rubber; but the natural fluctuations of the supply are much greater. Coffee is a plantation crop like rubber, and the bush takes three or four years to mature; but the berry fruit is harvested annually and the harvest varies greatly, partly owing to seasonal conditions and partly owing to the state of the trees. A bumper crop may be expected once in every three or four years and is nearly always followed by a short crop. The Brazilian scheme of control, which has been in operation in different forms for nearly twenty years, aims at regulating sales in bumper years and carrying over the surplus for sale in the lean years. Until the present slump the scheme appears to have worked better than might have been expected. In his study of "Coffee," published by the London and Cambridge Economic Service, Mr Rowe suggests that the general effect has probably been to give the producers about what would have been the average price over a period of years under *laisser-faire.* A stockholding scheme which achieves this successfully avoids a certain amount of economic waste, and reduces friction and loss through recurring bankruptcy and hardship to individual producers. The principles of the scheme appeal to the producers' desire for stability and sense of fair play, and experience suggests that central control and planning are likely to be permanent features of the marketing of Brazilian coffee. The present crisis is exceptionally severe owing to the combination of two good harvests with a world-wide depression of trade. It is being met by a tax on exports which is used to buy up part of the surplus stocks for destruction or for use as fuel. Given the inelastic nature of the demand and the fairly regular periodic fluctuations in the crop, coffee seems to be a favourable case for some form of artificial adjustment. But the limitation of the scheme to Brazil, though it is by far the largest supplier of coffee, is a source of weakness which may have to be remedied by an extension of the area of control.

(3) **Sugar.**—One of the most ambitious schemes of world planning which has yet been attempted is the Chadbourne Sugar Plan, embodied in an International Agreement to which producers' organisations and Governments in Cuba, Java, Germany, Belgium, Czechoslovakia, Hungary, Poland, and Peru are now parties. Since cane and beet sugar are annual crops, the supply is elastic and capable of fairly rapid expansion and contraction. The demand, on the other hand, is fairly steady and inelastic, the normal increase in consumption being about 3 to, at most, 5 per cent. per annum.

Cuba, the largest sugar-producing country, began to restrict production in 1926. Production had increased from 2½ million tons before the war to over 5 million tons in 1924-25. In 1926 the President was given power to prohibit further planting and to fix the total output of sugar and the output of each factory. For the year 1925-26 the output was restricted to 4·9 million tons, in 1926-27 to 4·5 million, and in 1927-28 to 4 million.

Partly as a result of Cuban restriction a rise in price took place in 1927 ; but production increased elsewhere and a fresh crisis arose in 1928. Germany, Czechoslovakia, and Poland agreed to limit exports, but Java, which had recently increased her yield per acre through the production of the famous cane called P.O.J. 2878, declined to co-operate. Cuba therefore abandoned restriction for the 1928-29 crop, and Europe expanded her sowings. The result was a fresh fall of price. The 1928-29 Cuban crop reached the record figure of 5·2 million tons, and Europe established a new record for beet sugar of 8·5 million tons. In May 1928 an attempt was made by the League of Nations to secure agreement amongst the producers, but it was not until the end of 1930 that the Java producers agreed to consider restriction. An agreement was finally arrived at in May 1931, known as the Chadbourne Plan, under which Cuba agreed to limit her annual production for five years to 3·5 million tons, and to draw 260,000 annually from her existing surplus of 1·5 million; Java agreed to limit annual exports to 2,200,000, plus 100,000 annually from surplus stocks; and European countries undertook to reduce exports by about 10 per cent. An International Sugar Council was set up to ensure the smooth working of the scheme, with discretion to vary the amounts released from time to time according to the course of the market.

In spite of this decision and the improved statistical outlook, the price of sugar—after a temporary recovery when the Plan was first introduced—continued to fall. The main reason for this appears to have been the further check to consumption caused by unemployment and reduction of consumers' incomes. The Plan counted on adjusting current production to consumption, and in estimating consumption the framers proved to be unduly sanguine.

The check to demand, though not statistically great, was of sufficient psychological moment to cause a complete demoralisation of the market in April 1932. Between April 1931 and April 1932 the price in Cuba fell by 50 per cent., from 1·2 cents to ·6 cents per lb. Fears were entertained that the Plan would be abandoned owing to discontent in Cuba and the difficulties of revising quotas on a lower level. Eventually the Cuban crop was fixed at 2,700,000 tons, and in July 700,000 tons of Cuba's allotted export to the U.S.A. were segregated to be held off the market until January 1933 or until the price reached 1·50 cents. This enabled the Plan to be continued on a revised basis, and the market recovered to approximately the same level as when the Plan was introduced. Stocks have been reduced in Cuba and Europe, and acreage has declined everywhere, including Java, considerably more than the Plan provided. Indeed it may be said that the provisions of the Plan for reducing output and exports have been largely nugatory, since the fall of prices has by itself brought about a still severer reduction. Experience shows, indeed, that the framers of the Plan were unduly optimistic, and only agreed after weeks of negotiation and with the greatest reluctance to cuts far smaller than they were later compelled to accept by force of circumstances.

(4) **Californian Canned Peach Control.**—The average production of Californian Canned Peaches was 12½ million cases from 1926 to 1930, about 15 million being reached in 1928, with a carry-over of 3¼ million. A bad crop in 1929 resulted in a reduction of the pack to 8·4 million and a reduction of carry-over to 1·7. In 1930 there was a bumper crop forecasted to yield 20 million cases.

The canners decided to pack 13¼ million, based on a normal rate of consumption. A scheme of control was introduced under which two-thirds of the crop was harvested, and one-third was paid for at a lower rate, on condition that the fruit was allowed to rot on the ground. In spite of this 1930 ended with a carry-over of about 4 million cases.

In 1931 there was a smaller crop, of which only about a quarter was purchased to be left to rot. The actual pack was about 8½ millions, but consumption again fell off, and packers were again left with a carry-over of 4½ million cases. The 1931 Plan also provided for uprooting, with compensation, about 6,700 acres.

In 1932 the peach crop was estimated to be sufficient for 14 million cases, which, with a carry-over of 4½ million, would provide 18½ million for sale by June 1933, as against sales during 1931 of just under 8 million cases. The larger canners proposed to limit the pack to 4 million cases; but conflicts of interest (both among growers and canners) created difficulties in enforcing so drastic a restriction, and the voluntary scheme of control broke down. The pack is now estimated at about 6½ million cases and the growers are in acute financial difficulties.

(5) **Meat.**—The schemes we have considered hitherto have been concerned with the problem of surplus production, and artificial regulation has taken the form of (1) stockholding, and (2) decrease of output by restriction or destruction. But planning or orderly marketing also includes regulating the flow of supplies over short periods. The distinction between the two is important. In short-period orderly marketing no attempt is made to restrict output or to hold up stocks with a view to raising artificially the price-level. Indeed, in perishable products, such as meat, fruit, and dairy produce, the possibilities of storage are limited by the nature of the commodity, and organised restriction of output presents serious practical difficulties.

The trade in chilled beef, which is confined to exports from South America to the United Kingdom, supplies an example of orderly marketing. Beef will keep in a chilled state for little more than the time taken to ship and sell it, and if it is put into store it has to be frozen and at once loses a large part of its value. It is therefore imperative to regulate shipments with the greatest exactitude to avoid gluts and shortages. This is done by agreement between the dozen or so refrigerated meat companies established in the Argentine which control the trade. A Freight Committee representing these companies meets periodically to allocate tonnage space between the various companies. The Royal Commission on Food Prices, reporting in 1925, suggested that this system might be liable to abuse, and recommended that the Food Council should have power to appoint someone to watch the proceedings of the Committee, and to see that advantage was not taken of their strategic position to reduce supplies and force up prices in this market. If a plan for meat quotas is now to be adopted, there would be no practical difficulty in requiring the Committee to use their organisation for precisely this object. Whether it would be equally practicable to reduce the supply of cattle offered for slaughter and devise any artificial scheme for regulating production and prices of livestock in the Argentine is more doubtful.

In mutton and lamb a similar policy of regulating shipments is pursued by the New Zealand Meat Producers' Board, a statutory body consisting of representatives of producers and the New Zealand Government. Mutton and lamb, being frozen, can be more easily stored, and the object of control is to avoid seasonal gluts and shortages and to maintain a comparatively steady flow of supplies to the British market throughout the year.

Sharp and unforeseen fluctuations in supplies from other sources must evidently militate against orderly marketing by Argentina and New Zealand. In the autumn of 1931 an exceptional increase of Australian mutton and lamb exports took place owing to a favourable season and the exchange premium. The result was a severe fall of price. The difficulties of regulating Australian meat shipments are considerable, owing to the uncertainty of the weather and to the numerous ports and areas of supply. It is probable, however, that attempts will be made to introduce some system of regulation in the near future.

In view of declining production in the Argentine and the possibility of a world shortage of beef in the next few years, it would probably be risky to take any artificial steps to discourage beef production. But statistics of cattle population and the trend of meat consumption are matters of great uncertainty. The data needed for a long-term policy are seriously deficient.

(6) **British Columbian Fruit Marketing Act.**—The experiments made in British Columbia to control the marketing of fruit are of considerable interest. Co-operative marketing at one time extended to 80 per cent. or more of the apple crop, but low prices and bumper crops caused a set-back to the movement, and not more than about 50 per cent. is now handled by the Associated Growers. An attempt was then made to improve the growers' position by statutory control of marketing. Under the Fruit Marketing Act, a Committee of Direction was appointed, consisting of a representative of the Co-operative Society and a representative of private traders, with an independent chairman. The Committee could give directions,

including directions as to the minimum price at which fruit might be sold, but it could not function as a single selling agency nor establish a pool. The attempt to raise prices by merely fixing minimum prices proved a failure. Growers who were unable to sell at the minimum price complained to the Committee of Direction, and asked permission to sell at the best price obtainable. rather than have their fruit rot on their hands. The Committee consequently had to be constantly altering their minimum prices, and in order not to bring trade to a standstill, they in effect did little more than give statutory recognition to the market price as determined by supply and demand at any particular time.

An amendment to the Act to enable a Statutory Pool to be established was then demanded by the growers, but the Government refused, partly on constitutional grounds and partly as a result of an unfavourable report by a special Commissioner.

(7) **The Berry Growers of California.**—The Berry Growers' Association of California is a co-operative society handling strawberries and other soft fruits, which may be mentioned as an instance of successful co-operative marketing. It has owed its success partly perhaps to the fact that it is managed by one man, the members and Board of Directors being content to leave matters very largely in the hands of their whole-time salaried manager. They also have a clear and limited objective : on the one hand, to enter into bulk contracts with jam manufacturers for guaranteed supplies, and on the other hand, to act as a central clearing-house for the widest possible distribution of fresh fruits through ordinary trade channels. By collecting prompt information about supplies, prices, and the state of demand in consuming centres, they are able to perform a valuable service to their members without antagonising private traders.

It may be convenient at this stage to pick out some of the points that emerge from this brief survey.

1. A distinction can be drawn between schemes designed to raise or maintain prices by controlling the volume of supplies, and schemes for regulating the flow of supplies to the market without any attempt to control prices or production.

2. In any scheme to raise prices by restriction of output the first essential is to control a sufficiently large proportion of the supplies. In commodities produced for a world market, this means controlling the whole or greater part of world exports. Rubber restriction in British Colonies broke down owing to the virtual impossibility of controlling the native producer in the Dutch East Indies. The great achievement of the Chadbourne Sugar Plan is that it covers the bulk of the world's exports to " free " or non-preferential markets.

3. Centralised stock-holding is an appropriate measure of defence to meet an emergency which is likely to prove of short

duration. This is the essential feature of coffee valorisation, where bumper crops are to be expected once in four years. Schemes of this kind represent an extension over a period of years of the principle of short-term regulation of the flow of supplies. The commodity must naturally be capable of being stored, and the cost of storage must not be prohibitive. Rubber is easier and cheaper to store than wheat, but less so than tin, which is one of the easiest and cheapest commodities to store. Coffee deteriorates and is relatively bulky. Chilled beef and fresh fruit are highly perishable and unsuitable for storage except for limited periods.

4. Adequate financing of stock-holding schemes is essential. Weakly held stocks that are liable to be sold at any time and overhang the market, defeat their own object and merely serve to depress the price still further. Coffee stocks have been financed by long-term loans repayable over periods running up to ten years. Sugar stocks under the Chadbourne Plan are segregated for sale in annual quotas over five years.

5. If stocks cannot be firmly held and adequately financed, or if the cost is prohibitive, it may be preferable to purchase the surplus for destruction or to compensate growers for not harvesting it. Examples of this are to be found in Brazilian coffee, which is burnt as fuel on the railways, and Californian peaches, which are allowed to rot on the ground.

6. Voluntary restriction of agricultural production is extremely difficult to organise. Hence arises the movement for statutory control, which makes it a punishable offence to produce or sell more than the legally permitted amount. This extension of the functions of Government runs counter to well-established principles and prejudices and is regarded as unconstitutional in the United States. It is a system obviously open to abuse. But so long as the powers of statutory control are exercised with caution and moderation (as they have been by the Producers' Marketing Boards in New Zealand), they may prove to be the instrument of bringing about improvements in the technique of marketing.

7. The attempt made in British Columbia to fix statutory minimum prices without control of either supply or demand may be regarded as an example of bad planning.

8. Voluntary Co-operative Societies do not generally seek to restrict production, but many have achieved a considerable measure of success in orderly marketing. Perhaps their most useful rôle is to perform services which supplement rather than supplant the activities of specialised salesmen. The collection and prompt dissemination of information as to aggregate supplies, and the guarantee of bulk quantities to manufacturers under contract, are as important as their excellent work in grading and standardising qualities.

9. Lastly, we have noted the short-term regulation of the flow of supplies as a legitimate and useful field for planning, of which illustrations may be found under private enterprise, as in Argentine chilled beef; under voluntary co-operation, as with Californian oranges and many other products; and under statutory boards, such as the New Zealand Meat Producers and Dairy Produce Boards. Under this system no attempt is made to fix prices (a short-lived attempt was made by the New Zealand Dairy Produce Board, but was soon abandoned) or to limit output. The object is merely to avoid temporary gluts and shortages by smoothing out the flow of supplies and thus mitigating but not preventing fluctuations in prices. Such a system is easier to organise and more obviously desirable in shipping to a distant market than in supplying a multitude of wholesale and retail markets in a crowded country like Britain. The most hopeful field for experiment under the Agricultural Marketing Act (apart from any temporary emergency measures that may from time to time be attempted) would seem to be to secure a more even flow of supplies to consuming centres by orderly marketing.

In conclusion I would stress once more the importance of more knowledge, not merely statistics and market intelligence, which are the foundation of all planning and orderly marketing, but studies of demand and objective analyses of marketing schemes, with as much emphasis on failures and the reasons for them as on successes achieved. We know that the economic system is sick. But before we can find remedies, we must have diagnoses ; before we can diagnose we must have more facts ; and fact-finding in this field means time and money which only Governments or large organisations can provide.

It was the agricultural depression of the eighties and nineties which led to the immense development of agricultural research. It would be encouraging if the present depression gave a similar stimulus to research in applied economics and particularly to the study of marketing problems.

FARMING TO MEET THE TIMES

An Example from Wiltshire

C. S. Orwin, M.A.

Director, Agricultural Economics Research Institute, Oxford

The conditions under which farming is being conducted in nearly every branch of the industry and in almost all parts of Britain are so difficult and impose such a strain, not only upon the resources but also upon the faith of the farmer, that the title chosen for this article calls for some explanation. How is it possible, it may well be asked, to farm to meet conditions as they are to-day ? Wheat-growing is possible only by reason of the subsidy; barley, except for the small quantity taken for malting, is selling below the cost of production, and the same is true of oats; meat prices have crashed, and the market for store stock has broken in a way which no one would have believed possible even two years ago. Of the more important products, only sugar beet and milk are selling at figures which even approximate to a fair commercial risk, and sugar beet is subsidised, and the limits of its cultivation are narrowly defined, while the increase of production of milk during recent years may precipitate a crisis in the dairying industry almost at any moment.

Conditions, indeed, are so bad that, if farming is to survive in this island, they must get better, and it is the purpose of this article to suggest that the day of recovery may, perhaps, be hastened. By thinking of the industry as something which never stands still, by realising that many things which were good practice yesterday may have no justification to-day, and by a readiness to take risks and to experiment with new machines and new methods, ways may still be found to lower costs and to bring them into a better relation with prices. There is no fixed standard of what constitutes good farming, and there may be more flexibility about the systems and the means of production from the land than is commonly accepted.

This, at all events, is the belief of a noted English pioneer of new methods. It is not suggested that everything which he has done to develop a new theory of farm management, a new standard of farm equipment and new methods in the cultivation of the land and the handling of crops and stock, would bring salvation to every other farmer, or even that each or any of them could be universally adopted. But this work is the result of a new outlook on the farming problem, and in the belief that some account of it may inspire other farmers to think again, and to overhaul their practice from stem to stern in the search for leakages and obstructions to progress, these notes and comments on Mr A. J. Hosier's farm and farm management have been written.

For that purpose it will be sufficient to begin the account of Mr Hosier's work with the purchase, in 1920, of the farm which he now occupies. He had been farming already for some twenty years with much success, but the work which has brought his name into so much prominence has been developed in the last twelve years. The farm is at Wexcombe, in Wiltshire, about eight miles south of the little market town of Hungerford. Wiltshire is a county of chalk Downs and tablelands, intersected by deep valleys. Most of the farms are large, and they were laid out, many of them, centuries ago, as were a large number of the parishes of the county, in long, narrow strips, which run from the vale up the steep slopes to the top of the Down.[1] Wexcombe is one of these farms. It extends to about 1700 acres, of which 700 acres are in the vale, and the rest runs up to the top of the hill, where it reaches an elevation of 870 feet. For a short time, Mr Hosier occupied the holding in partnership with his brother, but it was soon divided, and it was the 1000 acres on the hillside and top which fell to his share. Nearly one half of this was natural downland grass; the rest was arable land and practically derelict. For a start, the arable was seeded down with a cheap grass mixture, and cattle were turned out to graze while Mr Hosier made his plans. To complete this slight picture of the farm, it should be noted that the buildings comprised no more than a horse-stable and a few sheds, all of which adjoined the house at one end of the farm, and the downland was mostly unfenced and unwatered.

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[1] The boundaries of many of these farms were first defined in Saxon times, and reference to the original grants often shows that they remain unchanged to-day.

Mr Hosier had concluded, soon after the war, that the outlook for corn-growing was most uncertain, and that for the immediate future, livestock products offered the greatest promise. He determined, accordingly, to make his downland holding into a dairy farm. The work that he has done in a few years, in turning a semi-derelict arable and sheep holding into cow-pastures carrying a herd of some 500 milking-cows, can best be considered under the following heads: (1) the equipment of the land; (2) the dairy herd; (3) poultry; (4) arable cultivation and labour organisation; (5) methods of disposal of his produce.

1. **The Equipment of the Land.**—Many farmers have turned over to milk production from other systems of agriculture during the last ten years. Almost always, a considerable expenditure on remodelling and adapting the permanent equipment is called for. Under favourable conditions, a dairy of cows can be accommodated by adapting a bullock-shed or a barn to provide the necessary standings, and by fitting up a milk cooling-room. In more extreme cases, a cowshed, cooling-room, etc., must be built, and a water-supply laid on to buildings or fields, and sometimes to both. It is impossible to generalise about the cost of the conversion, which usually falls upon the landlord and is recovered by him from the tenant in the form of interest on his outlay, but it may be anything from £20 a cow downwards. Mr Hosier is his own landlord; his holding, as he bought it, was equipped with nothing to make it even remotely suitable for milk production. And here he showed the first example of the resourcefulness which has made his farm a model of economic organisation. Even on a good dairy farm, it is doubtful whether cowsheds could be built to-day as a commercial proposition. To house Mr Hosier's great herd on his downland farm in the accepted style would be to incur a certain loss.

And so he decided to do without housing altogether and to evolve an open-air system. His big upland pastures were divided into large paddocks by wire fences. A water-supply to every one of them was laid on, and with that the permanent equipment of the holding for dairying, as he conceived it, was complete. Everything about the work was done as cheaply as was compatible with efficiency. The use of barbed wire reduces the number of wires needed to make an adequate fence, and light posts of rough timber are sufficient to hold them. There are no ten-foot dressed field-gates hung on eight-inch oak gate-posts. At the point in the fence where the gate is wanted, Mr Hosier attaches one length of the wiring to a movable post, which is then shackled to the next fixed post in the line of the fence; it can be pulled up and the wires drawn aside when access to the field is wanted. Not only is the saving of cost on a large farm very material, but a gateway of any size can be made, which is a great advantage in these days when power implements, too large to pass through the old farm gateways, are becoming general.

The water-troughs are concrete, fed by ball-valves, and each one has also a tap on the main supplying it, from which water can be drawn at any time for engines threshing in a nearby arable field (Mr Hosier always stacks in the field, to save carting), or for any other purpose.

There is no other permanent equipment, and the cost of this, per cow, is negligible by comparison with that of the usual lay-out on a dairy farm.

2. **The Dairy Herd.**—A herd of some 500 cows is not easily collected nor maintained. Mr Hosier was confronted with the problem which has exercised many dairy farmers—should he aim at keeping a home-bred herd, or should he rely upon buying-in? His earlier experience of arable farming, before he went to Wexcombe, had convinced him of the fundamental need for specialisation in farm management. If labour and other production costs are to be kept down, it is essential, he holds, to consider each branch of the farm without reference to any other. "If you want to rear heifers, take a farm and rear them. If you want to milk, stock a farm with cows and milk them. But do not try to combine raising heifers and the milking of cows in one business." Considering the prevailing conditions and his own circumstances, he decided to make a start by buying in-calf heifers, relegating to the future the question of stocking another farm on which to raise his own cow stock.

The principle of specialisation is applied also to the organisation of the farm labour. Mr Hosier's practice is to arrange the work so that every man or every team have their own full-time occupation independent of the rest of the labour force. There are no odd men, jobbing first on one thing and then on another. "If you send a man to help men for half an hour, you do not see him again for half a day, and soon they will want him all the time." So the cows are divided in herds of sixty, each one being a full-time job for a man and a boy. Under normal dairy-farming practice, with hand-milking, a sixty-cow dairy would provide full-time occupation for five or six men. With a milking machine installed, the number would be reduced one-half. How does Mr Hosier contrive to do the work with a labour staff of less than one-third ?

The answer lies in the labour-saving milking-shed which he has devised. Mr Hosier's well-known milking-bail is a flat-roofed shed without a floor, lightly constructed and mounted on wheels. In it are arranged stall divisions to hold six cows, and a milking machine to milk them simultaneously. At the head of each stall is a manger, with a food hopper over it, the outlet being closed by an ingenious slide connected to a long handle passing to the back of the stall. One pull and thrust on the handle discharges a measured ration of food from the hopper. In a shepherd's hut drawn up alongside the bail is an oil-engine to operate the milking-machine, and a boiler to provide steam for sterilising all the utensils. Some of the outfits are equipped, also, with a dynamo, by which both the bail and the hut can be lighted for milking on dark mornings.

Each herd has its bail and hut which are drawn out into one of the big pastures where the cows are grazing. Round this equipment is erected a corral, consisting of a temporary fence of chestnut pales and wire. At milking times the cows collect in it, attracted by the prospect of their food ration, and enter the bail, six at a time. The machines are attached, the food ration is discharged into the manger, and after milking, a door in front of each cow is raised by a pull of a rope, and they pass out into the pasture. The bail is moved its own length daily, by a sheaf of pulley blocks and an anchor, operated by a pony, so that the cows are always milked on fresh ground. The corral has to be taken down and set up again about twice a week.

The manual labour unit of a man and a boy is supplemented by a pony and a float. This labour is full-time employed with the sixty-cow herd, doing nothing else, and receiving no assistance from other men. The float brings the concentrated food and empty churns to the field ; it delivers the full churns at the farm. At haymaking, all the bail labour teams combine to supply the labour needed to get the hay that their herds will want in winter.

The cows lie out on the pastures summer and winter, and their effect upon the downland has been remarkable. Rough grass and heather have been converted, in a few years, into good herbage by the constant treading and by the regular and even manuring by the herd and the passage of the bail up and down the land. If corn-growing should ever again become profitable, an immense reserve of fertility is being laid up in the Wexcombe fields at no cost to Mr Hosier, which could be drawn upon at twelve months' notice for arable crops, by laying up the bails and dispersing the herds. There is no expensive capital equipment of buildings and plant which would become unproductive by such a revolutionary change in the farming system.

3. **Poultry.**—When seven dairy-herd units had been organised and equipped, Mr Hosier concluded that his cow-stock was sufficient

for the time, but unwilling to believe that no further exploitation of his grassland was feasible, he began to consider the possibilities of poultry. Egg production was said to be profitable. It was carried on principally under two systems, the one intensive and the other extensive, and neither would serve his purpose as practised. The intensive system, depending upon expensive equipment and making no use of the land, was foreign to his conception of farming. The extensive method, in which small houses are distributed over a grass range, was unsatisfactory in that the land cannot be properly grazed and the manure is wasted, for either it is deposited on the ground under the houses in excessive quantities, or else it must be scraped from floors and removed, at a great expense of labour. But it occurred to him that if some system of poultry-keeping in floorless houses, easily movable, could be devised, it should be possible to carry a large head of poultry on the pastures already stocked by his cows, without this drawback. The herd would control the grass without labour cost, as poultry alone can never do, and houses moved every day would neither foul the ground nor entail a labour charge for cleaning. And so he devised the "Hosier Folding Pen," each to contain 25 birds, and they are placed in long lines across the paddocks in units of 160 pens, or 4000 birds. As with the cows, the labour force for each poultry unit is a man, a boy and a horse and cart. It is not possible here to describe the details of the methods of feeding, watering, egg-collection, or the nest with its false bottom. which prevents the soiling of the eggs by trampling, and so on. By an ingenious lever, each house is moved forward its own width daily, giving the flock fresh grass, leaving the manure thinly spread at no expense. and the cows will graze right up behind the pen.

Adhering strictly to his principle of specialisation, Mr Hosier breeds no birds. That is another job. Irish pullets are bought, and kept so long as they are profitable. Fowl paralysis and the diseases common in intensive poultry-keeping are unknown.

The poultry business is thus an extra, conducted on land which most people would regard as being already fully stocked, on a system which carries more birds per unit of labour than any other. At the same time it makes its contribution to the enrichment of the land.

4. **Arable Cultivation.**—Mr Hosier's open-air dairying is, of course, a grass-land industry. At the same time the cows need more food than that which is supplied by the herbage. In the winter it must be supplemented with hay, silage or green crops, and at all seasons some concentrates are fed. In 1929 an adjacent farm came into the market, and Mr Hosier bought it. The purchase added some 700 acres to his downland area, and about 800 acres of ploughland at the foot of the Downs. On this he set out to grow corn and green crops suitable for his herds.

Following his established practice, the arable area became a separate, self-contained unit in his business. Tractors and tractor implements were bought, and he organised a system of cultivation designed, as is all his work, to reduce costs to a minimum. Tractors can work all day, but as the drivers cannot, he decided to reduce the number of tractors needed by dividing the day into shifts, the drivers working eight-hour spells. In this way he has sometimes got twenty-four hours' work in the day out of his tractors, head-lights mounted fore and aft replacing daylight in the early hours of the first shift, and towards the close of the last shift. Sowing, as he does, on the furrow, it was obviously unnecessary to make a separate process of drilling, and a seed-box mounted on the four-furrow plough enables him to plough and sow at the same time. Turning the tractor at the end of each furrow entails a waste of time and a wide headland, so Mr Hosier ploughs round and round the fields, finishing with " X " headlands across them where the plough has to be thrown out of the ground at the turns.

Silage crops and oats are the main crops, but silage as usually handled—cutting, pitching into carts, carting to the silo, chaffing and blowing—is expensive. Mr Hosier has made several motor sweeps, which are ordinary sweeps mounted on the front of old, high-powered motor-cars bought literally for a few pounds, and with these he sweeps the swaths up to a stack-loader placed alongside a pasture in which the cows will be wintered, and there he builds a stack silo. There may be some waste on the outsides of the stack, but this is compensated many times by the saving in labour. In every other detail of the labour organisation there is the same thought taken to save expense. Often the tractors are working on tillage operations a mile from the homestead for days together, and so a trailer to hold a week's supply of fuel-oil has been made, for attachment behind the tractor, and journeys to the homestead for fuel are reduced to a minimum. The difficulty which always arises on the highly mechanised farm of carting by lorry over ploughland and soft ground, is got over by using motor-cars with trailers, and carrying the drive back to the trailer wheels—a 4-wheel drive. Hay is stacked in the pastures where it will be fed, and the corn—oats—is stacked and threshed alongside the pastures, the grain being stored on the spot to supply part of the concentrated food ration of the herd where it will be wanted, instead of carting to and from the homestead. The open-air system of cow-keeping eliminates all the cost of dung carting.

In short, no single one of the traditional or commonly accepted practices connected with livestock, cultivation or farm equipment is followed at Wexcombe until Mr Hosier has passed it in review and has satisfied himself, first, that it is necessary, and, second, that there is no cheaper way of doing it than the usual one.

5. **Disposal of Produce.**—Production and sale are two very different things, calling for different qualities in the individual concerned in them. There are good farmers who are indifferent salesmen, while others admit that much of their profit in more

normal times came from dealing on the market. The tendency to-day is to separate the functions, and the development of marketing schemes on a commodity basis in the near future may leave the farmer free to concentrate on efficient production, while he entrusts the sales of his products to marketing agencies representing his interests.

The collapse of the milk market, which occurred soon after Mr Hosier began dairying, and the impossibility of securing what seemed to him a fair price for his milk from the wholesaling firms, led him to seek an alternative outlet. The idea of retailing was considered and rejected, and he secured premises in a London suburb and converted them into a receiving depot, selling his milk from it to a small group of roundsmen. The district of each one was defined in his contract, so as to avoid overlapping, and each was under contract not to sell above a certain price. The figure was 1d. a quart below the price fixed by the London Trade, and Mr Hosier's sales soon reached the figure of 2000 gallons daily. The question of the railway rate was then considered, and unable to obtain a special quotation for this large quantity, he bought two 4-ton lorries and delivered the milk to the depot by road.

Mr Hosier's neighbours were anxious to participate in the service he provided, and it soon became evident to the Trade that his competition might become serious. So before long he was offered an opportunity to sell out, lock, stock, and barrel, upon his own terms, which were such as to secure him a satisfactory market for his milk for many years ahead.

Egg production is still in its early days, and no special selling organisation has been attempted. The eggs are auctioned in the local markets.

It is not intended to suggest by this brief account of the main features of Mr Hosier's work that farmers, everywhere, who are labouring under the acute depression of the present times can find a remedy in the slavish imitation of his practices. That would be absurd. Although he claims, and rightly, that there are thousands of acres of land which could be given over to profitable milk production by applying his system, and although he holds that on many thousands of acres already devoted to dairying, the costs of milk production could be reduced by adopting it, dairying is not the only farming industry. The object of this article is to stimulate a fresh consideration by farmers of everything that is involved in the particular branch of agriculture, whatever it may be, in which all or any of them are engaged, to determine if there are not still things to be done to reduce costs of production. It is common hearing and reading that costs have been cut to the bone, and that there is nothing more which can be done. In very many cases this may be true, but until Mr Hosier and a few others began to break with the tradition of mixed farming and to show how specialisation might reduce product costs, no one, for a thousand years, had challenged the practice. Until he introduced his open-air milking sheds, no one believed that it was possible to produce milk without the expensive cowshed equipment necessitated under the Public Health Acts ; no one had seen how to eliminate the heavy cost of the dung cart ; no one had realised that a man and a boy could supply all the labour needed by a milking herd of sixty cows. Until he developed his chicken-house, no one had been able to tend a poultry flock of 4000 birds with the labour of a man and a boy. Tractor hay-sweeps are not uncommon, but Mr Hosier saw how the old motor-car on offer at £5, with much useful life still in it, might displace the £200-tractor and do its work at three times its speed.

The combined plough and seed-drill, the four-wheel drive for the lorry, the fuel-oil trailer for the tractor, the clever device for moving the poultry pens, the rough-and-ready but effective gateways—all these and a score of other details indicate not so much the things and practices which others might adopt as the imagination, the spirit of inquiry, the open mind, the determination to self-help, the refusal to accept defeat, which have saved British agriculture in times of crisis before, and which were never needed so urgently as they are to-day.

THE INFLUENCE OF RAW MILK ON TEETH AND GROWTH

E. Sprawson, M.C., L.R.C.P., M.R.C.S., L.D.S.
Director of Dental Studies, The London Hospital

Before I say anything about the apparent effects of raw milk[1] on teeth it will be informative if I quote a few figures relative to the ordinary incidence of dental caries in children in this country.

Some years ago the School Medical Officer to the Education Committee of the Salop County Council recorded (1) his findings in the case of 3794 children aged 5 years. He found that :

95 per cent. had carious teeth.
The average number of carious teeth per head was 6·8.
1017 children had 10 or more carious teeth each.

Such figures, I may add, are not unusual.

What started my own investigations was the fact that about four years ago I noticed (2) that children admitted up to a certain age in an institution containing about 750 boys did not get caries in teeth erupted after they came there, or present " return " work. As the boys at this institution had been under my dental care for many years, I realised that I was up against some factor previously unknown to me, as my earlier experience of them was that they had presented a good deal of additional and return work during their stay at the institution.

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[1] Raw milk is milk which has at no time been heated to more than a few degrees above body temperature.

The only difference in their diet or environment that inquiry elicited was that, commencing two or three years previously, they had been issued with a daily ration of raw milk.

It therefore seemed to me that if raw milk and their immunity to caries were in the relation of cause and effect, then children who had been systematically brought up on raw milk from their earliest years should have no dental caries.

Such children are very rare in this country, but I found and tabulated 40 who had had it from $4\frac{1}{2}$ months of age, and the details concerning them are striking, as they showed no incidence of caries. In all these cases the feeding of raw milk began before 12 months of age. Present ages range from $2\frac{2}{12}$ to $7\frac{8}{12}$ year in 39 instances; the fortieth is aged $19\frac{6}{12}$ years.

	Number of Children.	Average Age at Commencement.	Average Age now.	Incidence.
Group I. . .	4	9 months	$5\frac{9}{12}$ years	0
Group II. . .	9	2 ,,	$3\frac{8}{12}$,,	0
Group III. . .	24	5 ,,	$3\frac{3}{12}$,,	0
Cases not seen by myself .	3	2 ,,	9 ,,	0
Totals	40	$4\frac{1}{2}$,,	4 ,,	0

In other respects their diet was such that one might have expected to find the usual amount of caries.

Another 58 who had started it at a later date, but before the age of six years, had no dental caries in any tooth which had erupted subsequently; and another 44 who had started it at the age of 10, when, of course, it cannot be regarded as a physiological food, showed that though it still seemed to have a considerable immunising effect on unerupted teeth, it was not quite so good as when commenced at the earlier age.

In searching for evidence elsewhere I have come across some interesting facts which seem to have a direct bearing on the hypothesis that raw milk confers an immunity to dental caries.

It seems that all primitive races who suckled their young till past the time of eruption of the deciduous dentition, such as Australian aboriginals, African races, Eskimos and others, had an absolute immunity to dental caries in that dentition in so far as is known; it may be argued that such a race as the Eskimos had no carbohydrate in their diet to produce caries. That may be so, but on the other hand, those who can speak authoritatively of African natives tell me they have never seen mouths so dirty with adherent sticky carbohydrate as are the mouths of these children. The Tristan da Cunha islanders are another striking example, perhaps the best for my purpose, as they only breast feed up to fifteen months and then go straight on to raw milk given warm and undiluted from the cow. As they use raw milk more or less throughout their lives they seem to keep up their immunity, so that those who have spent their entire lives on the island show as low an incidence of caries, not only as occurs among civilised peoples, but among the most caries free of primitive peoples such as the Maories or Eskimos.

The Pitcairn islanders, on the other hand, lend support to this hypothesis conversely, as after weaning, raw milk is unknown on the island, and they lose many of their teeth (notably, as one might expect, the incisors) in very early life from caries.

There is, in addition, a good deal of other supporting evidence among human races ; for instance, about a fortnight ago I received a letter from a Scottish medical practitioner as follows : " I was at the island of Barra (Hebrides) this year . . . and was much struck by the appearance of the school children. They looked so well and healthy and had such beautiful skins and such fine white healthy teeth. These children were brought up on raw cows' milk after being breast fed."

I am well aware that people brought up on a caries preventing diet, quite apart from raw milk, may be free from dental caries ; that, however, does not mean that they would prove immune if exposed to it, especially during childhood ; though most people acquire some immunity later on in life, whatever their upbringing may have been.

Veterinarians inform me that, normally, the young of most mammals are wholly or partly dependent on maternal or raw milk feeding, for a varying period usually approximating a quarter of the growth period. This would approximate six years in man, and it is worthy of note that those primitive races who breast fed their children for this length of time or longer (Maories, Eskimos, North American Indians, etc.) showed the lowest incidences of caries in their permanent teeth of the whole human race. It must be remembered that any comparison between the diets of man and other mammals always has this discrepancy present, that even primitive man usually cooks his food, and nearly always uses carbohydrates in not so unrefined a form as is compulsory with animals, and there is very often the further discrepancy that the form and the spacing of many of the other mammalian teeth also afford them additional and very material protection.

The gist of my hypothesis is that raw milk is conducive to perfection of dental development and structure, but one should regard the teeth as part of the body as a whole, and not as separate entities ; it is interesting, therefore, to note what other writers who have had occasion to use raw milk or to compare it with other foods or pasteurised milk have to say.

Dr Kempson Maddox (3), writing concerning rickets in Sydney, Australia, which has 2000 hours of sunshine annually, found evidence of rickets in over half of the children coming to hospital between the ages of 6 months and 2 years ; in treatment he found that cod-liver oil seemed to possess less anti-rachitic power than fresh cows' milk.

Dr G. Murray Levick (4), writing concerning the treatment of severe marasmus, often associated with other disabilities and infections in infants, found that with raw milk as the chief item in their diet he was able to attain greater success in treatment and more rapidly than by other methods.

Stenhouse Williams and Mattick, in a paper read before the Reading Pathological Society on 17th January 1929, found that during the period from birth to 3 months of age, 112 children on raw milk gained 1 lb. 13 oz. individually, whereas another 112 children on pasteurised milk gained only 8 oz.

The work of Leighton and M'Kinlay (5) in Lanarkshire, involving observations on 20,000 school children over a period of 4 months only, of whom 5000 had raw milk and 5000 had pasteurised milk daily in addition to the diet common to all, found that all those having milk showed a big increase in weight, height and mental alertness compared with the other 10,000 who did not receive milk ; and Stephen Bartlett (6), in reviewing and comparing the children on raw and pasteurised milk respectively who were tabulated in their work, showed pretty conclusively that the increases in weight and height throughout were greater in those who were on raw milk. Resistance to infection is also increased by the inclusion of raw milk in the diet.

Concerning animal experiments, Mattick and Golding (7) showed that rats fed on raw milk and biscuit made only from white flour and water were sustained in growth, health, weight, reproductive capabilities and normality in general during the four generations through which the experiment lasted ; whereas others kept similarly, except that the milk was *sterilised,* failed to live and reproduce beyond the original generation except in one instance, when a second generation of very stunted animals was produced, and even the original generation failed in many instances to reach maturity. Others, kept similarly but on *pasteurised* milk, demonstrated results sufficiently marked to indicate that during pasteurisation the milk had undergone changes which had considerably reduced its dietetic value.

The Auchincruive experiment now being carried out is also of interest ; groups of calves are being reared on raw and pasteurised milk respectively for comparison, and a recent report says that several of those fed on pasteurised milk have died, but none of the others. Calf experiments carried out at the Rowett Research Institute also proved that those fed on raw milk throve much better than those on pasteurised milk.

It is well known that children kept entirely on sterilised milk may suffer from scurvy, and this has also been known to occur when pasteurised milk is used similarly.

Bear in mind that, physiologically, milk passes direct from donor to recipient at body temperature, and also bear in mind that if any other secretion which physiologically passes direct from donor to recipient at body temperature were to be pasteurised or sterilised in transit we should none of us be here.

According to Professor L. Barthe (8) pasteurisation destroys most of the vitamins, the soluble ferments and enzymes, and brings about changes in the casein and lecithin ; sterilisation obviously will increase such damage. Leucocytes also are destroyed by heating.

The evidence of Mattick (9) is confirmatory, and also states that even at quite low temperatures changes take place in the diffusible calcium, that its diffusibility is changed and that experiment indicates that vitamins C and B1 are most susceptible to heat.

Concerning the effects of the deficiency or absence of individual vitamins on dental development : Vitamins " A " (Smith and Lantz (10), " B1 " (Kellogg and Eddy (11)), " C " (Howe (12)) and " D " (Mellanby (13)) have each been shown to affect the structure of dental tissues so, presumably, as to render them more vulnerable. All this tends to show fairly obviously that each is necessary for efficient development or calcification or both. When we see that they all apparently have to play their part it becomes obvious that the building of a tooth is not so simple a matter as it might at first seem. Knowledge of vitamins must be regarded as at present in its infancy ; the number attaining recognition has increased considerably in recent years, and we must at present admit the possibility that there may be different varieties of what at present are regarded as identical factors, some of which, dependent on their source, may have selective powers for the building of certain tissues. Raw milk, in so far as we know, contains all the vitamins, and it may be that the calcium is in a specially assimilable form, or even in combination with vitamins, for efficient tooth formation.

In view of the above, and if this raw milk hypothesis is a true one, it would appear that when there has been only a slight vitamin deficiency (either general or of a particular vitamin) during the development or growth period, liability to dental caries may, in later years, be in many cases the only sign that such deficiency has ever occurred ; and furthermore it will explain the frequent coincident association of robust health and good teeth, and show that neither robust health nor good teeth is dependent the one on the other, but that both are dependent on the same common factors, *i.e.*, the use of the best materials for producing ideal growth, calcification and resistance during the developmental period.

Within reasonable limits one may, by noting which teeth seem to be particularly prone to caries and knowing their developmental periods, even put a tentative date to the time when the deficiency occurred which was responsible for their lack of resistance.

One may say then, in addition to this hypothesis that the constituents of fresh raw milk seem to be the ideal material for perfection of dental structure and resistance, that there is evidence in *civilised* countries that the rest of the body is affected in the same manner, and indeed the physical perfection of many long-suckled *primitive* races has often been noted, quite apart from their dental perfection.

To my mind, however, the most valuable piece of evidence in support of this hypothesis is that a return to raw milk as part of a child's diet is but a return to physiological principles, because raw milk is the food provided by Nature for the child and so, I presume, must under the best circumstances be the ideal; though we must remember that, dependent on the feeding of the mother, the vitamin and other content of milk may vary considerably in both humans and bovines. Indeed the recent work of Mackay (14) has shown that quite a large proportion of breast-fed, as well as artificially-fed infants in this country suffer from nutritional anæmia, " which, though mild, was enough to double the mortality in the artificially-fed group."

Remember also that in those races to whom the use of cows' milk was unknown, if a very young child's mother died the child died also, as unless there was a nursing relative or friend to suckle it they had not the wherewithal to feed it. In this connection it is of interest to note that the Japanese, who breast-fed up to six and ten years, and who for some 600 years prior to 1870 did not use cows' milk as an article of food, have a proverb appreciative of the value of physiological feeding: " One sho (1·8 litres) mother's milk is worth 3770 measures of linen, 23,990 bundles of rice straw and more than 10,850 bushels of rice."

I would advocate that raw milk should be continued up to not less than the age of fourteen years, and although you may grant that civilised raw milk feeding should be a great deal longer than is usually practised, you may ask why it should be so long. There are several reasons:

1. There is clinical evidence that it lessens the incidence of caries in permanent teeth considerably if taken up to that age; even when not started till nearly ten the incidence of caries in second permanent molars in children on raw milk, as compared with those on pasteurised milk and cod-liver oil, was as 11 to 77 a few years later.
2. Six years might be quite long enough if a primitive diet were eaten, but such teeth cannot withstand the diets of civilisation loaded, as they are, with refined fermentable carbohydrates; one requires a super-tooth—hence the lengthened period, which clinical experience justifies.
3. Cows' milk is after all only a substitute, and it is indeed *Dei gratia* that it should so act at all.

It is unnecessary for me to stress how confusing the nomenclature of the graded milks is to the man in the street, but it will be obvious to you that tuberculin tested milks are the only ones that can be used raw with safety from infection with bovine tubercle, and even so, those milks from animals tested with the double intradermal test are safest.

I am fully aware that at the present time the putting into action of this counsel of perfection is an impossibility, but that is no reason why it should remain so ; indeed I do not think we should rest content to nurture our children on the infected secretion of diseased animals after it has been pasteurised or sterilised.

The milk of goats has much to recommend it, as goats are almost absolutely immune to tubercle. Children take goat's milk very well, and I know of several instances where it has apparently had the same effect of conferring immunity to dental caries. Indeed I am told that in the mountainous regions of Sicily there are numbers of people who are brought up and live largely on raw goats' milk who have immunity to caries throughout their lives.

There is a great necessity for meticulous accuracy in any recording of cases. So many people think that because their children have been brought up on " Certified " or " Grade A " (T.T.) milk they have been brought up on raw milk, whereas it is only *very* few of them who have been so brought up. This remark applies especially to that period from the cessation of breast-feeding till about three years of age, or, putting it in other words, just the period of eruption and post-eruptive calcification of those deciduous teeth which most often become carious. It is during this period that all milk is almost invariably heated up in the preparation of proprietary infant foods.

The children on whom the original investigation is founded are the orphan weaklings of a highly-civilised race and provide therefore so much the severer test. But if you look anywhere in the world where children are systematically brought up for 2½ to 3 years on raw milk, whether it is maternal, or that of cows, you will not, so far as I know, find caries in the deciduous dentition ; nor, if it is continued throughout their lives will you find it, so far as I know, in their permanent dentition even though their diet otherwise be of civilised type.

Though it is now ten months since my original clinical observations were published, neither I nor any of the dental surgeons who have been collecting cases for me, yet know of an exceptional case.

Captions in the professional and lay press are occasionally seen on the " Dangers of Raw Milk," but seeing that the whole mammalian creation has from its commencement been nurtured on it, it is obvious that the danger does not lie inherently in raw milk. Such caption should read " Dangers of Raw Milk *from infected animals*," which is, of course, quite another story. In view of the evidence in this paper it seems to me that no effort should be spared to obtain a supply of tubercle free milk, so that we shall not need to feed children on a secretion which has been detrimentally altered in a way which Nature never intended it should be.

The incidence of caries is known to increase with the degree of civilisation and, generally speaking, the higher the degree of civilisation the greater has been the departure from the use of raw milk (maternal or other) as the child's food, and the use of refined carbohydrate.

One may therefore say, that, with the advance of civilisation, impaired structure of the teeth and their greater exposure to injurious agencies have proceeded coincidently and increasingly.

It is of interest that one of the statements based on clinical evidence made in my original paper has since received striking confirmation by Hess and others (15) from radiographic, anatomical and chemical evidence ; my statement was : "One fact which emerges conclusively from this investigation is that well-formed teeth, having apparently a considerable degree of immunity to dental caries, though this immunity is at present of unknown limits, may be developed entirely independently of ante-natal care," and the confirmatory statement (the italics are mine) is :

"Roentgenologic and anatomic data were controlled by chemical analyses of the teeth. It was found that at birth only a small quantity of calcium and phosphorus had been deposited even in the deciduous teeth. At this time the total calcium phosphate laid down in the teeth of both jaws amounts to only about one-half a gram, which is 15 to 20 per cent. of the content of the fully developed teeth. *It is quite unnecessary and of little value to feed large amounts of calcium and phosphorus to mothers during pregnancy in order to bring about deposition of calcium in the teeth of the fetus. As the teeth undergo calcification throughout childhood, it would seem advisable to provide the child with calcifying factors throughout this span rather than to limit our efforts to the period of infancy.*"

My further statement that "ante-natal care, in addition, should make them (the developing teeth) even better," still however holds true, because it is obvious that deciduous (and other) teeth of 100 per cent. ideal precalcific and calcific development *must* be better than the potential 80 to 85 per cent. ideal (of calcification only) which Hess and his associates indicate as occurring post natally. This seems to indicate in no uncertain manner the extent to which, and the reason why, immunity to caries may vary, as it shows that the ideal formation of a tooth is dependent on ideal developmental environment from its commencement to its completion ; it is only logical to conclude that any lesser perfection of developmental environment will correspondingly lessen the immunity attained, which, in turn, will vary according to the time when the deficiency occurred.

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WASTAGE IN DAIRY COWS[1]

Norman C. Wright, M.A., Ph.D.

The Hannah Dairy Research Institute, Kirkhill, Ayr

It is appropriate that, in any discussion of the methods of increasing and cheapening stock production as applied to dairy cattle, the foremost place should be given to the factor popularly termed "wastage." There are two reasons for this. In the first place there is no doubt that the cost of depreciation due to wastage in stock is an important item in determining the extent of profit or of loss on dairy farms—a point which will be dealt with later. In the second place the factors responsible for wastage are not under the same voluntary control as, for instance, the methods of feeding or of general management. The cost of feeding may be reduced to a minimum by strict adherence to well-recognised feeding standards, and particularly by the adoption of a system of rationing based on the productive capacity of the individual animal. Again, labour costs may be largely controlled by adopting systems of management suitable to local conditions, and, in some instances, by the greater utilisation of mechanical labour. Wastage, on the other hand, embraces a number of factors which are at present largely outwith the control of the farmer—factors such as constitution, breeding capacity, and disease. Hence it is reasonable that emphasis should, at the present time, be laid on this aspect of herd management, in the expectation that increased interest will lead to increased investigation, increased investigation to the formulation of efficient methods of control, and the adoption of efficient methods of control to reduced depreciation in stock.

In dealing with the subject of wastage, it is necessary to clear up at the outset any misapprehensions which may exist as to the means by which it can be measured. Ever since the pioneer work carried out by Lawson in West Sussex, there has been a tendency to identify wastage in dairy cows with annual replacement figures. Thus, if the annual replacement percentage[1] is 25, it has sometimes been erroneously assumed that the average length of productive life of the dairy cow is four years, and that this denotes a high rate of wastage. Now it is obvious from Lawson's original results, and from the results of the more extensive investigations which have since been carried out in different parts of Great Britain, that replacement percentages alone are in fact valueless as an indication of wastage, since such figures fail to take into account the *causes* of disposal of the displaced animals. Thus the results obtained in investigations in Cambridge, Reading, and Scotland show that from 12 to 20 per cent. of recorded disposals (and therefore of replacements) are due to sale for profit, while similar percentages are drafted out on account of poor milk yield. Neither of these categories can be classed as wastage, since both are in fact profitable means of disposal—the one by reason of direct trading profits, and the other by the indirect profit resulting from the elimination of unproductive stock. Similarly since a large proportion of the animals in these categories will be drafted into other herds—that is, since their milking life is not necessarily ended—it is apparent that any figures in which they are included cannot be employed in estimating the total length of productive, or milking, life of the average cow. They can be used only to calculate the length of life of animals *in the one herd.* Annual replacement figures cannot therefore be used as a direct measure of wastage.

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[1] Contribution to a discussion on "Increasing and Cheapening Stock Production," read at the Meeting of the British Association for the Advancement of Science, York, 1932.

A fairly reliable indication of wastage can, however, be obtained from the study of the mortality rates of cattle at different ages, since such figures will provide an accurate estimate of the average age of dairy cows throughout the country, and therefore of the extent of premature losses among stock. Actual mortality statistics are, of course, unobtainable, but approximate values can be fairly accurately calculated from a study of the age distribution among large and representative groups of cows. Such calculations have been made by Buchanan Smith (1) for random groups of six breeds of cattle. Buchanan Smith tabulated the ages of the parents of about 2,600 pedigree calves born during a single year, and calculated the average age of the parents. For cows the average age at calving worked out for all breeds at 5¾ years, and for dairy breeds 5½ years. This would indicate an average productive life of about 3½ to 4 years. Buchanan Smith's data refer, however, only to pedigree stock. In such stock it is possible that there will be an abnormally high weeding out of unsatisfactory animals, particularly on account of poor milking capacity. It has already been pointed out that disposals under the latter heading cannot properly be classified as wastage, and Buchanan Smith's average values may therefore be too low. It appeared that a better estimate would be obtained by taking a selected group of cattle in which voluntary disposals would probably be reduced to a minimum. Such a group is available in the Class I dairy cows in the Annual Reports of the Scottish Milk Records Association. The minimum yield which must be attained by an animal in this group corresponds to 800 gallons of milk at 3·5 per cent. butter-fat, and since such a yield can be classed as highly satisfactory for Ayrshire cows, it is reasonable to assume that a high mortality rate at a premature age would, in such a selected group, hardly be due to voluntary disposal by the owner. Yet the mortality rate, as judged by age-distribution calculations, is abnormally high during the earlier productive years. For instance, it was found that, in 1931, the average calving age of over 7,000 animals [1] whose ages were recorded, worked out at 5·6 years, and that only 25 per cent. calved at ages over 6·5 years. Moreover, when the age at first calving (2·8 years) was taken into account, the average *milking* life, allowing ten months for the final lactation, worked out at 3·6 years, or only 55 per cent. of the total period of life. It is true that the data on which these calculations are based may also be criticised on the ground that they are obtained from too limited a selection of the cow population ; but the results, when taken in conjunction with Buchanan Smith's estimate, and with other estimates which have been put forward by informed workers, do show fairly conclusively that only a relatively small proportion of pedigree and milk recorded dairy cows live beyond the age of seven years.

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[1] The annual replacement percentage signifies the number of animals required annually to keep a herd up to full strength, expressed as the percentage of total actively producing animals in the herd.

Now Kay and M'Candlish (2), in very careful studies of the records of Ayrshire cows, have shown that the age of maximum production is reached at seven years, and that this level of production is in general maintained for the remainder of the productive life. *It follows therefore that the average dairy cow, under present conditions, barely reaches the age of maximum milk production.* Obviously this is a serious source of loss to the dairy farmer. Not only does he have to bear the expense of rearing his heifers for 2½ to 3 years without return, but at the end of this non-productive period he does not retain his stock long enough to enable them to reach their maximum level of milk production. Moreover, there is a still more serious aspect to this short productive life. In the breeding of dairy cows we are primarily dependent on the records of individual animals for effecting improvements in the general level of production of the various breeds. Recent studies, notably those of Buchanan Smith on Jersey cattle (3), and of Fowler on Ayrshire cattle (4), have in fact shown the low degree of inbreeding in these pre-eminently dairy breeds, as compared, for instance, with the Beef Shorthorn, the explanation being—at least in part—that breeders of dairy stock rely very largely on the recorded yields of their stock for effecting improvement in their herds. A short productive life, however, seriously prejudices the opportunity for making such a method of selective breeding effective, since the majority of cows are not in the herd for a sufficient time to exert a lasting beneficial effect on the stock.

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[1] As the percentage of heifers whose ages were recorded very considerably exceeded the percentage of cows, an appropriate adjustment was made in the figures used as a basis for these calculations.

Incidentally this is also true of dairy bulls, whose average age approximates only 3½ years. Premature disposal in this case does not provide the breeder with an opportunity of determining the bull's potentialities for milk production through his daughters' yields, which constitute the most reliable index of milk-transmitting ability. The factors which determine the relatively short life of bulls are, however, probably different from those which affect the length of life of dairy cows. They are more or less under the control of the herd owner.

Wastage, then, does occur among dairy cows as measured in general terms by the determination of mortality rate or of average length of life, and this wastage is definitely un-economic in that it leads to a shorter period of productive life, and to serious difficulties in effecting stock improvement by selection. To what factors is this wastage attributable ?

A study of the causes of disposal of cows from dairy herds constitutes the most important method of determining the sources of wastage. It is to Lawson that we owe the inception of such studies, but his method has now been applied on a very extensive scale in various areas throughout the country. The actual method of study has been to collect, through Milk Recording Societies, all available data on the causes of disposal of animals from the herds investigated, and also all possible information as to management, etc., which may have a bearing on the causes of disposal.

It is impossible to survey in detail this latter aspect of wastage, particularly as the evidence on many points is conflicting. It will suffice to summarise the more general conclusions, and to comment on them in a quite general manner. It might, however, be stated that information has been collected and published from West Sussex, and from five other southern counties, from all counties in the Cambridge and Reading provinces, and from Scotland. To give some idea of the extensiveness of the work, it might be added that the Reading figures relate to about 320 herds containing 9,500 cows, the Cambridge figures to 550 herds with 13,500 cows, and the Scottish figures to 450 herds with 22,000 cows. The conclusions can therefore be relied upon to give a fairly accurate picture of the present position in dairying districts extending over a large area. The collected figures are shown in Table I.

TABLE I

Summary of Published Information relating to the Causes of Disposal of Dairy Cows

Cause of Disposal	Scotland 1930	Cambridge 1928–29	Cambridge 1929–30	Reading 1929	Six Counties.[1]
NORMAL—					
Sold as surplus stock	19·4	17·4	20·9	12·0	14·5
Poor milk yield	16·6	19·6	19·2	19·4	21·0
Accident	1·5	1·2	1·4	1·9	..
Old age	4·9	5·3	4·0	4·5	3·5
Total	42·4	43·5	45·5	37·8	39·0
DISEASE—					
Failure to breed	17·2	23·7	26·8	26·2	24·8
Abortion	2·1	3·6	3·8	3·1	3·0
Udder diseases	15·0	7·0	4·7	6·4	5·7
Advanced tuberculosis and Johne's disease	5·4[2]	10·4	9·6	12·3	15·3
Failure to tuberculin test	2·8	2·4	1·8	5·5	
Total	42·5	47·1	46·7	53·5	48·8
MISCELLANEOUS	15·1[3]	9·4	7·8	8·7[4]	12·2
	100·0	100·0	100·0	100·0	100·0

It will be seen that the first group of figures has been classed as *normal* disposals. These include trade disposals and disposals on account of poor milk yield, neither of which can be classed as direct wastage, and disposals due to accident and old age, which are roughly constant for each centre and are unavoidable, and which in any event constitute a very small percentage loss. *Normal* disposals work out for all centres at about 40 per cent. of the total disposals of stock.

It is to the second group, i.e., *disease* disposals, that we must look for true wastage, and there is no doubt that the figures reveal a most serious situation. The over-all percentage of disposals due to disease works out at not less than 50 per cent. That is to say, one out of every two animals drafted out from a typical dairy herd is lost as a result of one or other of four main groups of disease—reproductive disease, udder infections, tuberculosis, or Johne's disease. There are, of course, local variations in the incidence of each group of disease. Contagious abortion (including failure to breed, which frequently has its origin in contagious abortion) appears generally prevalent, and accounts for as much as one quarter of the total annual disposals. Mastitis is far more prevalent in Scotland than in England, while the reverse is true of Johne's disease. The summarised figures do, however, indicate that disease is the real source of wastage in dairy herds.

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[1] Taken from 1931 *Yearbook of East Devon Milk Recording Society.*

[2] Johne's disease negligible.

[3] Includes some unclassified disease disposals.

[4] Includes 4·77 classed as "sundry diseases."

To the herd owner himself the significance of these figures is all too apparent, for there are few who have not at one time or another experienced heavy losses through disease. For those who are not so intimately in touch with dairy stock I would, however, quote the following short paragraphs, which will re-emphasise the seriousness of wastage from the point of view of the farmer's balance sheet. The statements are taken from a recent publication by Wyllie (5) which deals with the financial results of typical farms in his area:—

> *Farm* 11.—It is unnecessary to give further space to this herd, except to say that a disappointing milk yield, due to disease troubles, was the chief cause of the loss.
>
> *Farm* 12.—Over a four-year period this farm shows a loss of about ¼d. per gallon, with an average yield of 670 gallons per cow per annum. It is probable that, except for a severe outbreak of mastitis, a fairly reasonable profit would have been made, since the depreciation on cows was 2·3d. per gallon, while the milk yield was also less than it would otherwise have been.
>
> *Farm* 16.—The feeding problem has been tackled and, in a sense, solved on this farm ; the far more serious problem of how to keep the cows in a fit state of health is very far from solution.
>
> *Farm* 17.—A loss of over £16 per cow per annum, or nearly 7d. per gallon over five years . . . (and later) There can be no doubt, however, that the heavy loss was very largely due to disease troubles of various kinds which not only affected the stock account results, but also, of course, the milk yields. *This herd was milk-recorded and rationed, but the disease factor predominated over all others.*

Here is the wastage problem in its acute form, leading to poor production, interrupted breeding methods, and direct and tangible trading losses. Moreover, as I have stated in my opening paragraph, we do not at present possess weapons which will enable us to combat such wastage. The acquisition of increased knowledge of the methods of eradicating disease is the only means by which we can hope to gain any measure of control over the present losses. How are we to set about acquiring this knowledge ?

There is no doubt that at present the position is being allowed to drift. So far as organised research is concerned, practically no sustained effort is being made to tackle the fundamental subject of disease control. As far as I can estimate, not more than £25,000 per annum is at present being spent on disease research in the country, and of this sum, probably not more than one-fifth is devoted to research on the diseases of dairy cattle. Under normal conditions the obvious course would be for the agricultural community to bring strong pressure on the Government to subsidise disease research on a more adequate basis. It does not appear, however, that immediate success is likely to lie in that direction—at any rate for some time. What can be done in the meantime to overcome the present position of aimless drifting ? I believe that there are at least four directions in which hopeful results might be looked for, and which would at any rate provide us with a positive policy.

In the first place the herd owner himself can take an important part in combating this wastage. Much of the data which is summarised in this paper, and which forms the basis of our knowledge of the extent and causes of wastage, has only been collected through the voluntary assistance of milk recording societies, but even so the results have proved of every great value. But if the herd owner would himself keep adequate records of the health—as well as the productivity—of his stock, there would be available a far more valuable and extensive source of information regarding the conditions which influence wastage and disease. From the owner's point of view such health records would provide a useful balance sheet of his stock : just as he finds it profitable to keep accurate records of the consumption of his foodstuffs, or of his use of labour, with the object of detecting sources of waste, so would health records provide him with both motive and direction in tackling live-stock wastage.

Still more important, however, would be the value of such collected records when analysed by the trained scientific investigator. Let me take a concrete instance. A survey of Scottish tuberculin-tested herds was recently carried out (6) with the object of ascertaining the extent and sources of re-infection of such herds with tuberculosis. Although on most farms the records were far from adequate, the authors were able, by skilful questioning and by the careful sifting of evidence, to ascertain the sources of infection in more than 90 per cent. of the cases investigated. Moreover, practically all these sources of infection were found to be easily avoidable, and it was found possible, as a result of this survey, to draft practical recommendations by means of which re-infection could be prevented. This is only one special instance of the value of accumulated field data when placed in the hands of a trained scientist. In the more general aspects of wastage there are many points requiring elucidation : whether, for instance, there is any relation between high milk yield and the incidence of disease, and how far different conditions of feeding and management, and of rearing and breeding, influence wastage. Information on these aspects of the subject can be collected only by the owner himself, and would cost nothing but a small expenditure of time and trouble. Yet the information would surely yield most valuable results.

In the second place we do not at present make sufficient use of the veterinary practitioner in tackling disease problems. There is no doubt that an enormous mass of information might be made available if a suitable method could be devised for pooling the results of field treatment. Take, for instance, mastitis. There are numerous vaccines available for the treatment of this condition, but there appear to be no collected data as to their relative reliability. Yet there must have been hundreds of trials carried out independently by veterinary surgeons in different parts of the country, and the establishment of some system by means of which these results could be examined and correlated would surely add extensively to our knowledge of the treatment of udder diseases. The same argument applies to contagious abortion, though here, I am glad to say, Scotland is giving a lead in a scheme to tap the collected experience of the veterinary practitioner.

The two suggestions so far advanced have dealt, more or less, with machinery for collecting existing knowledge which is otherwise buried, and of using this knowledge in formulating methods of disease control. The two remaining suggestions are concerned with encouraging the application of existing knowledge.

In the first place, there is no reason why, in spite of the present lack of fundamental knowledge on the methods of disease control, some progress should not immediately be made on the preventive side by adopting measures which will limit the spread of bovine diseases. For instance, the immediate isolation of aborting animals, the careful disinfection of infected premises, and the effective destruction of infected material, might go far towards limiting the incidence of contagious abortion. Similarly, the practice of milking clean stock before those affected with mastitis, and the careful collection and destruction of milk from infected udders (in place of the dangerous practice of allowing such contaminated material to be milked out on to the byre floor) would undoubtedly help to reduce the risk of conveying udder infections to clean stock. These are only typical examples of precautions, elementary in themselves, which would at least constitute a definitely constructive effort towards disease control, and thus tend to reduce wastage.

In the second place, I think that it is true to say that Government funds have, in this country, been devoted almost exclusively to two aspects of disease control: laboratory research, and palliatives to the more advanced cases of disease—such as, for example, the slaughter of clinically tuberculous animals under the Tuberculosis Order. At present the country pays over £75,000 per annum in compensation for slaughtered animals under the Tuberculosis Order, while administrative figures also run into a very large sum. Yet there is little doubt that the incidence of bovine tuberculosis is not being reduced to any considerable extent in this country. Would it not be wiser, especially under the present financial conditions, to spend our money constructively? At present no incentive is provided by the Government to the progressive herd owner to eradicate disease from his stock: the available funds are devoted to relatively ineffective measures in the most infected and least progressive herds. Yet it is extraordinary what a small degree of encouragement will accomplish. Two and a half years ago the Hannah Institute, with the assistance of the Medical Research Council, started an experimental eradication scheme in a small area in Scotland. The only incentives provided were free tuberculin testing, and free expert advice on methods of eradication. To-day practically two-thirds of the herds in the area are free from the disease, while practically all the remaining herds have substantially reduced their initial percentage infection. This is an example of the effect of a little practical encouragement in eliminating wastage from our dairy herds. The same principle could probably be used in combating contagious abortion: voluntary systems of abortion eradication are, in fact, being successfully run in the United States. And the cost of such encouragement would not, at any rate in its initial stage, entail any increase in Government expenditure; it would merely mean the diversion of money, now utilised uneconomically in providing palliatives, to the financing of definitely constructive measures.

Briefly, then, in combating wastage, I would advocate, first, the co-operation of the dairy farmer in keeping adequate records of the health, as well as the productivity and management, of his stock; second, the initiation of a scheme for collecting and correlating the mass of field data which could be made available with the veterinary practitioners' co-operation; third, the encouragement of simple hygienic measures designed to control the spread of disease infection; and fourth, the provision of Government assistance towards voluntary schemes of disease control—based, for instance, on free diagnostic tests and free expert advice—particularly in eliminating tuberculosis and contagious abortion, as a substitute for the present expenditure on the Tuberculosis Order.

I have, perhaps, taken a rather wide interpretation of "wastage" in opening this discussion. But I feel that the importance of the subject is such that we must discuss it in the broadest possible terms, and in as constructive a manner as possible. If dairy farming is to maintain its outstanding position in British agriculture, and if our dairy stock are to retain their unrivalled reputation for excellence, wastage must be eliminated. Only by this means can we ensure for the dairy cow a reasonable chance of long life, and for the dairy farmer an economic return for his labour.

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THE BIOLOGIST ON THE FARM
No. XLVIII

Sir J. ARTHUR THOMSON, M.A., LL.D.

Emeritus Professor of Natural History in the University of Aberdeen

Dopa! Black Sheep.—The chestnut-coloured riddle still goes its rounds: Why do black sheep eat less than the white ones? It has been satisfactorily disposed of, but we are happy to announce a new answer less obvious than the one usually current. The new answer is: Because they have so much melanin, which is made out of dopa. And if it be asked: What, then, is dopa? the answer is, dihydroxyphenylalanine, an answer that is not in any way amusing except to those who have managed to remain immune from chemistry.

Our remarks have to do with the common, darkish pigments of mammals, which are called melanins, familiar in negroes and dark horses and black sheep, but also well seen in our noble selves, unless we are albinos. These melanins are derived from amino-acids, such as tyrosine, which in turn are derived from the proteins of the food. Melanin is an oxidation-product of tyrosine, the oxidation being due to a widely distributed ferment or enzyme called tyrosinase. But an intermediate product between tyrosine and melanin is dihydroxyphenylalanine, called "dopa" for short, which differs from tyrosine in being convertible into melanin within the epidermal cells. The final step is due to some oxidase different from tyrosinase. In other words, the epidermic cells (in the innermost or malpighian stratum) are powerless to transform tyrosine directly into melanin. Red substance may occur between dopa and melanin, but there seems to be only one pigment in the varied coloration of the sheep's fleece.

The production of melanin in the sheep has been recently studied by Evlyn Boyd, M.Sc., in the Institute of Animal Genetics, University of Edinburgh; and we wish to refer to a few of the results of her able research. The generally accepted theory of melanin-making is corroborated. The *nuclear* origin of the oxidising enzymes is confirmed, and so is the conclusion that the sheep has only one melanin. It is suggested that in the sheep some epidermal cells are more potentially pigment-producing than others, and that a gradation exists between the cell which cannot produce pigment and that which produces it to a maximum degree. This is dependent on the genetic constitution.

The investigator notes that the pigment-producer (dopa) and the enzyme may both be present without any melanin resulting. There are numerous opportunities for physiological interference which inhibits the final result. The colour tones in hair are quantitative and not qualitative, and are due to the arrangement and distribution of the pigment in the hair follicle. " The experiments with dopa suggest that an inhibitor is not necessarily a specific substance, and that the effects attributed to it are due to quantitative and qualitative differences in the constituents of the pigmentary system. Melanin in tissue may exhibit every shade of colour from palest buff to most intense black. Genetic black is the most stable form of pigmentation, red the least."

Whiteness in wool fibres may be due to : (1) absence of melanin ; (2) insufficiency of melanin ; (3) presence of " white " melanin ; and (4) physical properties concerned with the structure of the fibre by means of which light rays are reflected. The white melanin, where the pigment granules have no dark colour, may be the result of over-oxidation.

As regards seasonal whitening, as in the Mountain Hare and the Ermine, there is no support for Metchnikoff's theory that pigment-devouring cells wander up the medulla of the hair and carry off the pigment granules. Moreover, it seems that neither outside influences nor internal nervous disturbances can effect colour-change *after* the melanin is deposited in the fibres. Winter whitening in the hair of Ermine and the like is due to differences in the new hairs produced, or to bleaching of the melanin granules before they are finally deposited. This very interesting paper is published in Part II of vol. lii of the *Proceedings of the Royal Society of Edinburgh* (1932). The word " terraces " on p. 220 is surely a misprint.

Trophic Influence of Nerves.—It is at first sight a far cry from the American catfish to the health of calves, but a substratum of protoplasm makes the Animal Kingdom one. Professor G. H. Parker, to whom we owe so many illuminating researches, has been studying the " lateral line " system in the catfish, *Ameiurus nebulosus*, and has been led to the very important conclusion that all nerves are trophic, *i.e.*, capable of influencing the nutritive and general metabolic condition of the parts they supply. A century ago nerves were regarded as *sensory* and *motor*, but soon it was found necessary to add *inhibitory* nerves and *secretory* nerves. Later on there was a general recognition of the reality of *trophic* nerves, concerned with the nutrition of parts. Now Parker brings forward the conclusion that all nerves are trophic, and he bases this on a study of the lateral line nerve of the catfish. This nerve, familiar in most Bony Fishes, runs from the back of the head to near the tail, and gives off two dozen or more lateral-line organs, which are probably receptive to movements in the water and to vibrations of low frequency. It is experimentally possible to study the degeneration of these sensory organs when the innervation is cut off, and their subsequent regeneration as well. And what the observed facts suggest is the passage or percolation of a hormone-like substance (or more than one) along the nerve to the dependent sense-organs. The substance is believed to emanate from the nucleated portion of the nerve-cell, and to make its way along the nerve-fibre. It is believed to be essential to the normal metabolism of the fibre, as well as to the welfare of the receptor cells in the sensory buds which the nerve-fibres supply.

But why may it not be an ordinary nerve-impulse, which is nowadays generally interpreted as of the nature of an ionic re-adjustment ? Parker's answer is that a true nerve-impulse in a catfish travels at the rate of something like 80 feet per second (as compared with about 100 in a frog and about 400 in man), whereas the trophic passage has a rate of about two centimetres (say $\frac{4}{5}$ inch) per day. This contrast shows that the trophic transmission is very different in nature from a true nerve impulse.

Parker's conclusion that all nerves are trophic is based on his studies on the catfish, but there is not anything unique in that animal, and the conclusion is likely to be generalised. In a deep sense it may be true that the mind feeds the flesh. In any case, what a fine instance this story affords of *organisation*—that omnipresent quality of living organisms, the vital linking of part to part, the " give and take " of the many members of the one body.

If it should be asked why the trophic functions may not be left to the blood and lymph, instead of dragging in nerve-fibres with percolating substances, which reach the sensory cells and keep them in good condition, we suppose the answer would be that what the nerve-fibres contribute may be something *very special*, like a vitamin in ordinary diet. It has also to be remembered in regard to cases like that which started the investigator on this new tack, that there are practically no blood-vessels in the epidermis itself, to which the lateral sense-organs belong. But in any case, Professor Parker has, after his manner, submitted facts which give us furiously to think, as the Frenchman says.

If the reader asks what was actually seen, we suppose that Parker would say *a progressive degenerative wave, travelling at a very slow rate.* The observed appearances seem to be reasonably interpreted by supposing that there is an actual percolation of a material " something " within the nerve-fibres, but this does not imply that the " something " was actually seen.

Submergence of the Hippopotamus.—We are not claiming the hippo, Job's Behemoth, as a farm-animal, but we have seen a water-vole, a water-shrew, and several other mammals submerging themselves on our beat, and the problem is much the same whatever mammal we choose, barring whales and porpoises, seals and manatees, which have undergone for ages a racial apprenticeship to aquatic life. A small manatee from Florida can submerge itself for four and a half minutes, and a large one for about twelve. And besides the slowly wrought-out permanent modifications, such as blood-storing reservoirs and large lungs, there are individual habituations to be kept in mind. Thus a newly-born seal will readily drown, but an adult with difficulty. It has been shown that a human being, freely provided in advance with pure oxygen, can keep his breath under water for fifteen minutes, though the usual limits are three or four. Startling an animal usually prolongs the duration of the dive.

But let us return to the hippopotamus and his submergence. It must be confessed that man dearly loves a wonder, and many of us have experienced a strange feeling of elation when able to tell our neighbour something that verges on the incredible. So it has been common enough to read in books that a hippo can submerge itself for ten minutes, quarter of an hour, even half an hour. "According to Keeper Robinson, a hippopotamus at the Zoological Gardens in London, after having been scared, plunged under water and remained there in clear view without bringing its nostrils to the surface for twenty-nine minutes as timed by a watch."

But when Professor G. H. Parker timed two resting hippos in Hagenbeck's Zoo in Hamburg, he found that the average lifting of nostrils to the surface was about once in fifty seconds. This corroborates a few very careful previous records, but it is far below the majority. Can it be that alarm—a psychological motive—enormously increases the normal physiological period; or was there some error of observation in previous cases?

Parker notes that a Common Porpoise swimming quietly in a pool breathed on the average about four times a minute, whereas that of a normally resting man, not very different in weight, is seventeen to eighteen breaths per minute. Dolphins in the open sea are said to have one respiration every three minutes. There is evidently room for further observation, but there are no cetaceans on the farm.

Do Living Tissues emit Rays?—One of the most striking of recent suggestions is that radiations may be accompaniments of certain cellular activities, and may produce effects at a distance. Thus a Russian biologist, Gurvitsch, claims to have shown that when growing cells divide they emit rays which accelerate the processes of division in other cells. To these suggestions Sir Frederick Gowland Hopkins gave enhanced interest by his provisional appreciation in his Anniversary Address to the Royal Society last November.

He said : " Work by many during the last year seems to have brought satisfactory proof that chemical reactions in living tissues are indeed accompanied by radiations, and events in one cell may thus influence other cells without material transmission." " That activities in living cells may be accompanied by radiations recognisable by physical means is now, I think, a fact which is proved." It may be that this clue will lessen the uniqueness of cell-division. It certainly leads us to look at the glow-worm with fresh interest.

Identical Twins among Animals.—We notice a recent statement that the occurrence of " identical twins," meaning two offspring from one ovum, is an open question for animals. But it seems to be a little misleading to omit a reference to the poly-embryony of two species of Armadillo, namely, *Dasypus hybridus*, where there are in the majority of cases eight embryos of similar sex from one ovum, and *Dasypus novemcinctus* where the number is almost invariably four. The occurrence of identical (monozygotic) twins has been *alleged* for deer, swine, and sheep, but so far as we know it has not been proved. Of the occurrence of fraternal (dizygotic) twins there is no doubt in sheep, goats, cattle (one in fifty ?), horses (once in ninety ?), cats, dogs, pigs, monkeys (common), and deer (rare). But some search should be made for identical twins in common mammals.

The normal production of quadruplets or of octuplets—all of the same sex—from one ovum is going a long way in reproductivity, but it is far exceeded by the poly-embryony of some parasitic Hymenoptera, where one egg may produce a chain of a thousand—all female when fertilisation has occurred, all male if the ovum develops parthenogenetically. Beyond the fact that several embryonic areas are isolated, the peculiarities behind the multiple twinning are unknown, and so are its advantages.

Insemination in the Rabbit.—It is difficult to say who first saw a spermatozoon enter the substance of an ovum, and, apart from historical precision, it does not matter very much how the credit should be divided amongst those who certainly made important observational contributions. It seems that the two who came *nearest* were Martin Barry (in Edinburgh) about 1843, who observed fertilisation in the rabbit, and Newport, ten years later, who observed the spermatozoon forcing its way into the frog's egg. The question is carefully discussed in Professor Cole's *Early Theories of Sexual Generation* (1830), who remarks that Leeuwenhoek's assertion (1683) that fecundation is effected by " one of the animalcula getting into the yolk of the egg " is robbed of its apparent prescience by the genius's belief that the spermatozoon represents the fœtus. For this belief demands the corollary that only one spermatozoon enters the ovum. Cole also reminds us that the understanding of what fertilisation implies came much later through the researches of Oscar Hertwig, Weismann, and Fol, between 1875 and 1879.

How did we come to think of Barry and of what he observed in the oviduct of the rabbit ? The stimulus came from another inquiry by Professor G. H. Parker into the factors which bring the spermatozoon and the ovum together in insemination. As the Biologist on the Farm has previously recorded here, Parker has found that the oviducts of the turtle and of the pigeon possess narrow *pro-ovarian* tracts of cilia by which spermatozoa may be carried from the lower part of these ducts to the neighbourhood of the ovary. These sperm-wafting *pro-ovarian* tracts are absent in the rabbit.

He gives this summary of conclusions : (1) spermatozoa are transferred from the vagina of the rabbit to its uterus by the muscular activity of the duct ; (2) they pass up the uterus by their own locomotion ; (3) they ascend the Fallopian tube possibly by their own locomotion but chiefly through transportation by counter currents induced by the cilia ; (4) the egg, in consequence of its size, so presses upon the ciliary surfaces of the tube that the cilia become effective in the downward passage of this body and thus supplement peristalsis. No trace of pro-ovarian cilia was found.

Ploughing without a Plough.—We do not refer to the agricultural work of earthworms, to which is due most of the fertile soil of the globe. They certainly were ploughers before the plough, and are still bringing earth to the surface at the rate of ten tons per acre per annum in average arable soil in Britain, and covering the surface with their castings at the rate of three inches in fifteen years. To a considerable depth, varying in different soils, they have been making the earth circulate for countless generations, and we should not allow our familiarity with their work to blunt our gratitude. But we are thinking just now of another kind of non-instrumental ploughing referred to in the November-December Number of *Natural History*, the journal of the American Museum.

The Water Buffalo of India and Malaya is one of the big animals of the modern world, for it may stand six feet high at the shoulders and have massive horns six feet long. It is now called *Bubalus bubalis*, but perhaps it would have been better to leave it as a species of Bos. It occurs both wild and tame.

Mr H. C. Raven, of the American Museum of Natural History, tells us in a very interesting way how the natives of Central Celebes use this great ox in the preparation of the rice fields. At the beginning of the wet season the rice-fields are covered waist-high with grass and weeds, and the black soil beneath is rather hard. Water is let in from the irrigation ditches to a depth of several inches, and then the ploughing begins. Meanwhile two or three dozen water-buffalos have been getting ready in a large pen. The intractable ones are dealt with in various ways, chiefly through the dietary or by elimination. Then the big herd is driven into a rice-field to do what they like, provided they "move on." They are driven round and round over the soaked soil, and " the large cloven hoofs soon make a mire of the fields, at each step pressing the grass down." This goes on till all the grass has disappeared, and the mud is without lumps to a depth of two or three feet. "The shiny, wet animals wallowing along with the mud-bespattered brown men striding after them are a very pleasant sight, while their shouts and chanting add to the interest." After a few days the women come to the ploughed fields and plant the seedlings of the rice-plant.

Origin of Petrol.—There have been many theories as to the origin of oil-beds, but the most justifiable conclusion seems to us to be that which refers the oil to the accumulation of minute plankton organisms, such as Crustaceans. But this origin may include a considerable variety of creature, and there is no reason to suppose that the same thing has happened everywhere. Thus we are not unsympathetic towards the heretical thesis of Professor J. M. Macfarlane, long ago well known in the Botany Department in Edinburgh University. We are glad to see that he is still going strong, both in learning and teaching. He holds that life began in the fresh waters, spreading thence to land and sea; and as to oil, he argues (from remains in particular formations) that it is largely to the credit of Metanemertean worms. Volcanic dust also played its part in upsetting the balance of aquatic life, and killing off shoals of fishes, which sank to rest, shrouded in algæ and rock-dust. Whence the petrol in our cars.

A Versatile Snail.—No friend of agriculture can rejoice over the versatility of snails, but it is always well to be prepared for the worst. Our native Helixes and Limaxes are not easy to combat, though ammonium sulphide and the like may be looked to with some confidence, but let us be glad that we have not to deal, in this country at least, with the Apple-Snail or Pila. An excellent Laboratory Manual of this Indian Gasteropod by Dr B. Prashad has been recently published, and it seems to be the most versatile of molluscs. From a review in *Nature* (19th November) we make bold to quote this intriguing paragraph. "Usually a denizen of fresh-water, Pila can, in the case at least of *P. globosa*, tolerate that which is brackish; usually vegetarian, it may eat dead animal matter. It has both aquatic and äerial respiration at its command; it can swim as well as crawl in water, and yet can travel overland and even climb trees, while it lays its eggs on land, and specimens left dry in a cupboard rivalled the celebrated desert-snail of the British Museum by being found alive after five years." Such is the *insurgence* of life.

Notes and Queries.—Pieces of fat fastened on the end of strings were hung as usual in the garden from the cross-bars of rose-trellis and the like. The meals began on Monday morning, and the Blue Tits and Great Tits were soon in evidence. Without any fumbling they lighted on the swinging fat, and pecked with gusto, some starlings looking on. Next day we noticed the starlings making attempts to follow their neighbours, but in vain. With strong lunges they knocked off corners of the fat and retrieved some of these from the watchful robins on the ground beneath. From a short side bar, past which the fat swung, they got some effective bites; but lighting on the booty was beyond them. The tentatives, usually by two birds together, continued on the Wednesday, and on Thursday morning, with mixed feelings, we saw the starlings light and peck effectively as they swung to and fro. In all likelihood they had learned a difficult piece of gymnastics, and in a very short time; but we cannot be sure that the starlings who tried were the same birds from day to day, or that they were quite inexperienced to start with.

A visitor to the Murray River in Australia records the interesting fact that domestic cats kept in the wilds bring their kittens fishes as well as other animals. Was this a reawakening of a mode of hunting which the wild ancestor made much of ? But we are not sure who the ancestor of the domestic cat actually was. Moreover, the domestic cat retains a very nimble intelligence, and many novel variations in the quest of food have been recorded. We have read that the Egyptian Cat, which does not seem to have been of the same species as ours, is depicted on some monuments as accompanying its master to the fishing and even diving into the water after booty. There is a record of a cat teaching its youngsters to fish, a subtle way of casting bread on the waters. It is also said--but our question is simply whether the cat who occasionally fishes is unconsciously reminiscing or is making a new departure in the art of life. As to the occasional fishing there is no room for doubt. We have ourselves known . . .

The same Murray River observer tells us that the ticks on the Australian Monitor are black when adhering to the black areas of this lizard's skin, and yellow when on the pale ground; and it is suggested that this is protective coloration, hiding the ticks from hungry eyes which might pick them off. But is it the same kind of tick in the two cases ? If so, can one and the same tick be yellow at one time and black at another ? Are there hungry eyes that notice ? And so on and so forth.

Dr L. O. Howard, who has done much to direct State Entomology in the United States, has written a book called *The Insect Menace*, in which he makes one other appeal to educated mankind to take insects a little more seriously. Perhaps books are blunt instruments in reform, perhaps the popular imagination is more or less immune to anything but the locust at the door, perhaps the conquests which impress the outsider have been due to state-organised enforcements rather than to individual experiments—anyhow the individual watches the insect menace unexcited, just as he watches and shares in the diffusion of the Grey Squirrel or the ravages of the Musquash.

Dr Howard tells us again that insects have strengthened their foothold for forty million years, and are shaking the world every day, not only along economic seismic lines, but as regards health and happiness directly. For 1919 it was estimated that the ravages of insects reduced the value of crops in the United States by £400,000,000. And while he tells us that seventy of the countries of the world have their Entomological Bureaus as part of the national service, and have at their disposal an enormous power of secure knowledge and expert investigation, it cannot be said that mankind has learned its lesson. When a particular crisis occurs we often fight very well, and then as conquerors we are conquered and relapse into muddling along. Just as it is not easy to explain the ethical defect that allows us to tolerate, for instance, so much persistence of rickets in our midst, so we wonder at our tolerance of a hundred and one insect-pests.

Bees and Vitamin E.—Many of us have pondered over the fact that one bee-grub may develop into a prolific queen, while another, which seems to have the same hereditary start, becomes a worker, only occasionally reproductive. The bee-keepers tell us that the larvæ which develop into workers are those which are weaned from royal jelly when not more than three days old, henceforth receiving only honey and pollen. Those that develop into queens, however, are fed solely on royal jelly, which is believed to be a secretion of pharyngeal glands.

To test the luminous theory that an abundance of the reproduction-favouring Vitamin E is the crucial distinction of the royal jelly diet, Sir Leonard Hill and E. F. Burdett (see *Nature*, 8th October) have experimented with rats, and have found that the addition of a little royal jelly to young rats had a marked effect on reproductivity. The numbers were small and the duration of the experiment was short, but " the evidence so far appears to justify the conclusion that the bees add Vitamin E to royal jelly, on which queens are raised, and withhold it from worker larval food." It would be interesting to feed more royal jelly to larvæ beyond the first three days—they are fully fed in about six days—to see whether there was any increase in the number of the occasional " laying workers," whose eggs are said to be capable of developing into drones. It would also be interesting to make a precise study of the reproductive system, including more than the ovaries, in workers reared from larvæ fed with royal jelly on, say, the fifth day. Rats are all very well, but we must come to know more about the treatment of the weaned bee-grubs after the first three days.

In bygone years we had valuable opportunities of discussing such problems with Dr John Anderson, the well-known Bee-Expert of the North of Scotland College of Agriculture, and we recall his emphasis on the fact that queen and worker differ not only as regards reproduction, but in many other ways, not obviously correlated. Thus the worker has not only pharyngeal jelly-making glands, but wax-glands and pollen-basket, none of which are developed in the queen. Moreover, the worker has a better tongue than the queen and a better brain. On the ingenious dietary theory must it be supposed that the royal diet inhibits the development of certain structures in the queen, while pollen and honey activate them in the worker. This is a difficult hypothesis.

Evolution of Hormones.—We find it satisfactory to think of the evolution of black sheep, or the like, because, with the help of investigators like Miss Boyd (see *ante*), we can more or less account for the presence of the pigment-producing material (say, " dopa ") and the change-evoking oxidase. But when we think of hormones, we are puzzled that hormones should have arisen which are particularly wanted and should have found susceptible tissues either waiting for them, or arising to take advantage of them, so to speak.

Dr David Landsborough Thomson, of M'Gill University, has suggested (*Nature*, 8th October) a useful way of looking at the problem. The hormones may have begun as vagaries of metabolism or constitutional variations, and have continued for a while without justifying their existence in any particular way. There are many instances of persistence through what might be called evolutionary momentum, but the familiar limit to this is that the by-products become disadvantageous. By and by, however, there is evolved a tissue which is peculiarly and usefully susceptible to the hormone, and then the linkage is established. This useful responsiveness may spread and may become more intense, and the hormone comes to have more or less marked survival value.

The value of the suggestion now put forward—we have heard an approach to it from others—is that it is accompanied by instance after instance of a confirmatory or illustrative nature. There are in some marine Annelids cells like those which produce adrenalin in ourselves, but an endocrinal function has not been proved for these types. The substance from the mammalian pituitary body which causes in experimental conditions a contraction of the uterus has been found in Elasmobranch fishes where its function, if any, is unknown. So there is an œstrin in insects, though we dare not call it a sex-hormone. The mammalian pituitary has a vestigial representation of the substance which causes expansion of pigment-cells in Amphibians and in Bony Fishes. A substance from the anterior pituitary stimulates the development of mammary glands in the guinea-pig and the " crop-gland " (is this a distinct secretory organ ?) in the pigeon—two very diverse responsive tissues. There seems a good idea here.

PEAT MOSSES—I

THEIR DEVELOPMENT AND EARLY UTILISATION IN SCOTLAND

IAN M. ROBERTSON, B.Sc., Ph.D.

Macaulay Institute for Soil Research

IN regions where humid climatic conditions prevail a rich growth of water-loving plants is usually found on the wetter parts of the land surface. With the course of time the dead parts of these plants fall to the ground where, if sufficient moisture exists, they are covered with water which more or less completely excludes air and micro-organisms and prevents decomposition or putrefaction of the organic remains. These (together with any animal remains which should be present) form what is known as *peat*, and the area where the above process of peat formation is taking place is commonly called *peat land*. The most favourable conditions for peat formation are undoubtedly to be found in the temperate zones, but peat has also been found in subtropical and tropical regions where organic remains have been preserved in swamps.

The gradual accummulation of organic matter from the peat-forming plants slowly raises the land surface above the level of the stagnant or very slowly flowing ground water, and in doing so alters the conditions of growth existing in the surface layer, causing a new succession of plant communities to spring up. The precipitation in a humid climate, combined with the naturally high-water holding capacity of peat and peat-forming plants, maintains sufficient surface water to exclude air and enable the peat-forming processes to continue as before. In this latter case, however, the peat exhibits characteristics differing entirely from those of the peat formed below or at the surface of the ground water.

Fens.—If the topography is such that drainage water rich in plant nutrients from a good mineral soil can collect in hollows, lakes, etc., then a growth of water-loving plants, such as reeds (*Phragmites*) and sedges (*Carex*), which at first spring up round the edges and in the shallower parts, gradually spread over the whole area filling it up to the level of the ground water with a peat rich in plant foods. Such an area may be termed a Fen (German—*Niederungsmoor*; Swedish—*Kärr*). The peat so formed may be called Fen Peat, and is subdivided according to the dominating plant from which it is formed, thus—Carex peat, Phragmites peat, Hypnum peat are peats formed from Carex, Phragmites and Hypnum respectively. Sometimes trees and shrubs grow in the shallow parts (Carr type) when Brushwood or Forest Peats, for example, Alderwood peat, are formed. It will be observed that while the development of the whole area of Fenland is dependent on the topography of the underlying mineral soil, the type of Fen peat formed is determined by local conditions such as climate, exposure, etc.

Mosses.—The further formation of peat on the overgrown Fen, and indeed on all areas except hollows, lakes, etc., where the accumulation of Fen peat has not reached the surface level of the ground water, is dependent on climatic conditions. Where dry conditions exist the growth of shrubs or even forest (as in Middle Sweden at the present day) is favoured, but where excessive moisture prevails the vegetation is usually Heather (*Calluna and Erica*), Sphagnum mosses, Cotton grass (*Eriophorium*) or Scirpus, forming areas known as Moorland. It can readily be understood that in most cases no sharp line of demarcation can be drawn between forest and moor ; generally one merges into the other with the gradual change of climatic conditions. Thus it comes about that, with the appearance of wetter conditions, a forest area may be destroyed by the invasion of the more rapidly growing moor, and conversely, dry conditions may accelerate the growth of a forest so much that it spreads over the moorland. The destruction of trees by moorland is caused by the waterlogging of the soil either through bad drainage or abundant precipitation. The wet conditions favour the growth of water-loving plants, which spring up round the bases of the trees ; these eventually die off and fall into the soft peat forming on the surface of the ground.

The effect of climate can also be traced in the development of moorland areas. Where the rainfall is not too great the peat-forming plants are usually most abundant in regions of low elevation, and often cover huge areas with a very soft mossy peat to depths of anything up to 40 feet. The surface of such an area is usually convex due to the more rapid plant accumulation in the centre than at the edges. Generally there is a drainage channel round the margin where water from the peat land and from the surrounding mineral soil collects. This natural channel is known on the Continent as a "lagg," and is a characteristic of peat formations in a district of medium rainfall. Since the lagg removes much of the water from the neighbouring moor surface, it follows that the growth of the water-loving plants, and accordingly the accumulation of peat, will be retarded. Usually the vegetation in this area consists of stunted trees, heather, blaeberries, etc., but as the distance from the lagg increases the rapid peat formers such as mosses, cotton grass, etc., make their appearance, with the result that the area gradually assumes a convex shape. Such an area of moorland is known as Hochmoor in Germany, Högmosse in Sweden, and " moss " in Scotland, but to distinguish it from other moss formations it may be called a " Raised Moss." In regions of higher precipitation the drainage effect of the lagg becomes less and less, and the presence of sufficient surface water maintains the growth of the most active peat-forming plants even at the margins. In this case the surface of the moss is almost flat and the lagg, when present at all, is badly developed. In the extreme cases, where the moisture conditions are excessive, even steep hillsides become wet enough to allow of the formation of peat. In such regions vast areas of hilly country may be covered with a thick layer of rapidly growing peat. Such country has a drainage system which runs through the moorland (Swedish Dråg) instead of round it as in the case of the "Raised Mosses."

The peat found on such moorland is usually formed from sphagnum, heather, blaeberry, cotton grass or scirpus, and is called sphagnum peat, heather peat, etc., and since these plants flourish in a medium very poor in plant foods the peat formed has a correspondingly low mineral content. The accumulation of organic matter is accompanied by the production of acid organic compounds, so that peat with a low mineral content has a high acidity.

Climatic History.—A close study of our peat deposits reveals not only the types of plants which have grown in our country, but also gives us a means of tracing its past climatic history. Thus sections through our oldest peat mosses show at the bottom Arctic plants such as the Arctic Willows (*Salix reticulata* and *S. arbuscula*) and Dwarf Birch (*Betula nana*), remains of an Arctic-alpine vegetation which flourished on the areas laid bare by the retreat of the glaciers after the Great Ice Age. Large pools of water were abundant and aquatic vegetation comparatively luxuriant, so that the formation of the Fen type of peat was very common. The gradual approach of a dry and warm period (the Boreal Period) can now be traced, when almost the whole of Scotland, including the Hebrides, was overgrown with forest, which reached an upper limit somewhat similar to that of present-day forests. Remains of birch, pine, oak and hazel found in our mosses are evidence of the vegetation of this period. Heavy rains now set in and, with moist, warm, oceanic conditions prevailing, the moorland spread over large areas at the expense of the forest, and, especially in the higher parts of the country, covered the trees with a layer of peat. A submergence of the land also took place, and it often happened that peat deposits were covered with water and a layer of mineral matter deposited on them. It is at this time that our Carse Clays in the Forth and Tay valleys were laid down. It has been deduced that this wet period (the Atlantic Period) extended over 3000 years from about 5000 B.C. to 2000 B.C., after which warm, dry conditions, accompanied by a raising of the land surface, set in. This period (the Sub-boreal Period) was the warmest in post-glacial times, and almost the whole of Scotland was covered with a rich forest growth up to about 1650 feet. To a large extent the woods were mixed deciduous (*e.g.* oak groves), but in places pine and birch forests were common. The rise of the land laid bare the carse lands, which were soon covered with oak forest. Some idea of the size of the trees may be obtained from the dimensions of part of an oak dug from the peat in Kincardine Moss on the Forth, which measured

50 feet in length and over 3 feet in diameter, while 314 growth rings were counted in one of the roots. In moorland areas not covered with forest the formation of peat was checked by the warm, dry climate, and in such cases a thin black strip of well decomposed peat mixed with heather and grasses takes the place of the tree remains. Altogether this period, into which falls the Bronze Age, occupied the space of about 1000 to 1500 years, after which the climate again degenerated, gradually becoming moist and cold (the Sub-Atlantic Period). The result was an increase in the moorland areas and a decrease in the forest. Birch replaced the oak, and generally the upper limits of the tree belt became lower. It was about this time that the Romans invaded this country and found it so thickly wooded that their historians described it as "horrida silvis" (fearful with woods). The Forest of Selkirk reached from Ayr to the Lammermuirs, but the largest area of all was covered by the Caledonian Forest (Silva Caledonia), which stretched over Central and North Scotland.

In many parts of the country the natural advance of the moorland brought about by the deterioration of climate was hastened by man. The Romans, for example, suffered heavy losses through sudden attacks of the Britons, who found the forest exceedingly useful for this type of warfare. Accordingly the invaders set about felling large areas of woodland, and evidence of this has been found in the peat mosses, where remains of large trees, some with wedges and axes in them and some burned, have been found. The destruction of the trees filled up the natural drainage channels, so that large areas of what had been forest land become boggy wastes and, with the abundant precipitation, formed excellent sites for the growth of peat-forming plants and the accumulation of peat. Thus for example in the Carse of Stirling we find the deep peat deposits of Flanders Moss overlying an area which was thickly wooded in Roman times. Later, in 1308, Robert the Bruce, after defeating Cumine, Earl of Buchan, at Inverurie, sent out parties to set fire to Cumine's estates, which lay in the neighbourhood of Inverugie, where charred remains of oak, alder, birch and hazel have since been found deep in the mosses. While human agencies may tend to accelerate the growth of moorland, it must be emphasised that the deterioration of climate which began five to ten centuries B.C. and which has continued up to the present day, will invariably bring about the same result if the natural processes are allowed to act unchecked. This applies to any land surface where an abundance of water exists, either through bad drainage or high precipitation, or a combination of both these factors.

Utilisation.—From very early times the utilisation of peat mosses has presented a difficult problem to mankind. Peat has long been used as a fuel in Europe, especially in districts where a scarcity of wood existed (its use is said to have been introduced into Orkney and Shetland by a Norwegian, Einar, about the year 890), but it is not until fairly recent times that we find any record of the cultivation of peat land, although it is certain that grass- and sedge-covered moors were used as pastures and meadows early in the history of this country. Indeed, in some of the thickly wooded areas the open moorland must have constituted the only grazing. It was recognised, however, that the growth of moorland could be checked and ultimately stopped by removing the excess moisture from the area, and all efforts at moor cultivation have in common as a first essential the establishment of a satisfactory drainage system.

Anderson[1] gives minute instructions for the drainage of peat moss based on experiments of his own laid down about 1770. His channels, which had slightly sloping sides and a flat bottom, were allowed to run for some time, after which a triangular furrow was removed from the bottom of the side drains. Large peats were then placed flat over the furrow and the drains (except the leader) filled in. The procedure resembles the modern continental one very closely. Three other modern practices were recognised by Anderson, viz., rolling, the use of lime, and avoidance of over-draining. To prevent over-draining in very dry seasons he describes a system whereby the field drains were led through open channels at the edge of the field where the water could be held back by means of turfs. This again closely resembles the modern German system. He observed that rolling increased the growth of clover at the expense of sorrel, and tended to firm up the peat, and here again was much in advance of the continental workers.

Aiton[2] and Steele[3] endorse Anderson's views on the above points but also give details of crop rotations and instructions for the use of lime, compost, etc., on reclaimed moss soils. Aiton, at the request of the Highland and Agricultural Society of Scotland, visited many districts where peat land reclamation was in progress and described the methods used, and the measure of success which attended the ventures, while Steele published letters from various moss improvers giving details of their methods and observations.

In some cases the peat lands were drained and cultivated without any further treatment, but generally it was found that in addition to drainage some means of increasing the supply of plant foods had to be devised. The methods of enriching the moss earth (as the soil formed from peat moss was called) which were brought into use about the middle of the eighteenth century can be grouped as follows :

(1) Paring and burning.
(2) Treatment with dung, seaweed, etc.
(3) Treatment with lime and composts.
(4) Covering with clay, soil, gravel, etc. (*a*) by hand ; (*b*) by flooding.

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[1] Anderson, J., *Treatise on Peat Moss* (1794).
[2] Aiton, W., *A Treatise on Moss Earth*, 1811.
[3] Steele, A., *A History of Peat Moss*, 1826.

Paring and Burning.—The practice of paring and burning the surface of peat mosses, one of the earliest methods of moor cultivation, continued to be used extensively until about the end of the eighteenth century, when it began to be prohibited on account of the harmful effects attending its use.

The procedure adopted was to drain the moss by open ditches and, after the surface had dried sufficiently, to remove a thin paring of peat which was gathered into heaps and burned. The hot ashes were scattered over the surface, which was immediately sown with bere. Usually the first two or three crops harvested were satisfactory, but the yields gradually fell off until after five or six years they were so poor that the burning operation had to be repeated. Modifications in the rotation were numerous, potatoes and oats being used instead of bere, but it was soon observed that a grass-clover mixture was the most satisfactory crop on peat, and in many cases the land was laid down in pasture immediately after burning.

The repeated burnings required to maintain satisfactory crops soon produced a light corky and insoluble material which formed a most unfavourable soil, and in addition often removed the covering of peat, exposing a shallow mineral soil or even bare rock. Again, the fire once started was difficult to control, and a surface pitted with holes was often the result. The early writers, Anderson and Aiton, in advocating the use of dung, lime, etc., strongly condemned the practice of burning, which of course soon rendered useless a complicated drainage system like Anderson's.

Treatment with Dung, Seaweed, etc.—About the year 1750 dung was used on Strathaven Moss for the production of grain, and this appears to have been the first reclamation of its kind in Scotland. The moss, which extended to about 200 acres, was drained and hand dug, and received dung in the spring of every second or third year at the rate of 5 to 6 tons per acre. After the first or second year, when a good soil had formed, the yield of corn was generally 8 to 12 bolls and often as high as 16 bolls per acre. Before reclamation the rent of 100 acres of the moss was half-a-crown, but about 1810 had risen to forty shillings per acre. Many other examples could be given from this period, but after the use of lime became known it was generally recognised that liming, followed by dunging, was more beneficial than either of these operations alone. In coastal areas seaweed and fish refuse have been used either alone or mixed with dung. Dung and peat were often composted in heaps and spread after decomposition had taken place.

Treatment with Lime, Marl, and Composts.— The first liming experiments were carried out in Ayrshire in 1760 and proved very successful, especially on grass land. The increased yield accompanying the use of lime encouraged some farmers to apply extraordinarily high dressings of that substance with the result that the crops were a total failure. The error was soon observed, however, and moderate liming became a recognised practice in the reclamation of peat land.

Anderson makes the following observation: "Of all the manures that have been tried upon moss, no one can be compared to calcareous matter, under whatever denomination it may be applied, whether lime, marl, chalk, or shell sand. If the quantity of calcareous matter be sufficient, the effects appear to be little short of enchantment. . . . Shell sand, which is the cheapest calcareous matter . . . is a treasure the value of which cannot be estimated. . . ."

Aiton goes a step further in recognising that lime was more than a manure. In discussing calcareous earths he says: "They accelerate the decomposition and putrefaction of the animal and vegetable matter in the soil and convert them into the food of plants. It is in that manner that they enrich not the soil, but rather the present crop at the expense of the soil. . . . The moss . . . is not, in its natural state, disposed to yield anything to the growing plants. That which would enrich them is locked up by insolubility, and remains dormant in the torpid moss-earth. Lime or any calcareous manure . . . renders the vegetable matter soluble and sets at liberty the vegetable food which it contained. . . ." It is known to-day that lime brings about bacterial decomposition, rendering soluble the unavailable nitrogen in peat. These principles were applied to the manufacture of compost manures which were formed by mixing peat and lime in heaps and allowing to stand until a friable mixture was obtained. Sometimes dung was added at this stage. Another method consisted of burning peat and lime together and applying the ashes to the soil.

It would appear that the Scottish investigators recognised the value of lime in the reclamation of peat land about a century before those on the continent.

Covering with Clay, Soil, Gravel, etc.—(*a*) By hand.—A light dressing of clay or soil was often used in reclaimed land in somewhat the same way as we use artificial manures to-day. A rich soil was generally chosen and applied along with lime or dung to increase the concentration of plant food in the peat. Another method consisted of coating the surface of the moss with a layer of clay or soil to a depth of some inches, after which cultivation proceeded as on a mineral soil. The material was carried on to the moss from neighbouring land, or in the case of the shallower mosses, from the bottoms of the ditches or "gotes." This method was of course expensive, but produced good and lasting results. Many examples could be given, but one in particular deserves mention. In 1754 a Committee of the Quarter Session of Justices of the Peace of Stirlingshire was appointed to examine improvements on Flanders Moss where the peat, which was about 15 feet deep, had been earthed and cultivated The Committee examined under oath some of the "most understanding farmers in that neighbourhood" who were familiar with the work carried out, and obtained the following:

"1mo. That the moss could be brought to carry good barley or any other grain. with less expence than the outfields either of kerse or dry field.

"2do. That it can be kept in tillage cheaper than any of these soils, and yield as good grain of all kinds.

"3tio. That any country man can labour a farm of moss with less than half the stocking necessary for any other farm, with less hazard of failing, and have as good a return.

"4to. That when it is properly cultivated, the moss will stand wet and dry seasons better than any soil around it."

Covering with Clay, Soil, Gravel, etc.—(*b*) By flooding.—This method depended on the flooding of the moss with water carrying mineral matter in suspension, but was usually very expensive to carry out unless a suitable stream ran in the immediate neighbourhood of the moss.

One other type of peat land reclamation, or more correctly reclamation of mineral soil from peat land, deserves mention. In 1766 Lord Kames entered into possession of the Blair-Drummond estate, which includes part of Kincardine Moss, and set about reclaiming the carse clay which lay underneath a layer of 3 to 14 feet of peat. A stream was diverted through the moss in a narrow channel cut down into the clay, and into this the peat from a 10-feet strip alongside was thrown and floated off into the Forth. As the work progressed the channel was moved farther into the moss. Work continued slowly until a large wheel for raising water was constructed on the banks of the Teith in 1787. The reclamation was for the most part carried out by Highlanders, who were given 38-year leases of 10-acre holdings, wood for building purposes, and sufficient oatmeal to support themselves. No rent was paid in the first seven years, but in the eighth, one merk (1s. 1⅓d.), and thereafter an annual increment of 1 merk until the nineteenth year was charged. After this 12s. per acre for reclaimed and 2s. 6d. per acre for unreclaimed land was paid. By 1845 nearly all the peat moss on Blair-Drummond had been removed, giving 1500 acres of good arable land. Many other landowners in the neighbourhood made use of this method, with the result that some thousands of acres of the best carse soil were reclaimed.

Summary.—The general plan followed by the early Scottish investigators in the reclamation of peat mosses was to drain the land, lime it to reduce acidity, and then to supply plant foods in the form of dung, compost, or a top dressing of mineral soil. The crops which were found most suitable were oats, bere, potatoes, and especially grasses and clovers. Pasture on peat land, if properly limed and rolled, was acknowledged to be superior to that on mineral soils.

This scheme varies in one fundamental point from modern continental practice, namely, in the use of artificial fertilisers. While the early Scottish investigators recognised that plant-foods had to be added to moss soil, they had no means of applying these in a concentrated form, and had to resort to the less efficient methods already described. When the use of artificial manures did become profitable in this country the outlook had changed. Although at the beginning of the nineteenth century Scotland appears to have been in advance of continental countries in the reclamation of peat land she has made no contribution to the modern development of that branch of agriculture. Thousands of acres of moorland were reclaimed in this country, but the gradual cessation of such work may be said to have accompanied the agricultural depression which has become increasingly obvious since the latter part of last century. It is within the last few decades that the greatest developments have taken place in modern continental methods. The introduction of new machinery for drainage and cultivation work, and the decrease in the price of suitable artificial manures have made moorland cultivation a comparatively simple matter, so that even in these times of economy it should be possible to carry on such work. Apart from any large scheme of land reclamation one possibility which suggests itself is the gradual improvement of rough moorland pasture, or even of some of the lower-lying mosses, by the farmers themselves. It may be observed that such a reclamation need not involve the operations of land cultivation and crop-production which are so often erroneously understood from the word reclamation, but can be carried out by modern manurial and seeding methods. In some districts it may even be profitable to cultivate the reclaimed land.

A REGISTER OF PROVEN DAIRY SIRES IN SCOTLAND

Andrew C. M'Candlish, Ph.D., B.Sc., N.D.A., N.D.D., and
A. N. Black, B.Sc., N.D.A.
The West of Scotland Agricultural College

Milk recording did not start in Scotland until 1903, but progress has been such that this country may now be looked on as one of the leaders in the practice. There are many ways in which milk records can be of value to the dairy farmer, such as in aiding him to detect and eliminate his poor producing cows, and to control the feeding of the herd in accordance with the production of the individual animals. Important as recording may be for these purposes it can be used to even greater advantage. This is as a guide in breeding, but unfortunately records have not been used for this purpose as frequently as they might.

Records as a Guide in Breeding.—The breeding of dairy cattle is an intricate problem, and all the aids possible are necessary if the best results are to be obtained. Milk records can be of value in this connection by aiding the dairy farmer in the selection of his herd sires and of the cows from which young stock are to be kept.

The dairy farmer who aims at success must first of all have a herd of cows capable of giving high milk yields. There are great variations in the ability of dairy cows for milk production, and as producing ability is inherited, though the laws of this inheritance are not yet definitely known, a very careful selection of breeding animals is essential. Consequently both the dam and the sire must receive consideration.

It can easily be seen that the choice of a sire carries far more responsibility than the choice of a dam. A low-producing dam will stamp her characteristics on only a few daughters, whereas a poor breeding bull may sire a hundred daughters or more and so ruin a herd. The sire is indeed a vital factor when an attempt is being made to improve a herd or to maintain a high standard of production, and up to the present great difficulty has been encountered in the choice of breeding bulls.

In the reports of the Scottish Milk Records Association cows are grouped under the names of their owners, and the records of a cow are obtained by searching through several volumes of reports. This is hard enough, especially where a cow has been moved from one herd to another, as it is often difficult to trace these movements. It is even more difficult to obtain information regarding the breeding value of a bull because the records of each of his daughters must be traced.

Need for Selection of Sires.—It has been shown time and again that there is great variation in the value of dairy sires when compared on the basis of the production of their daughters. It is not proposed to discuss this question here, as the problem, so far as Scotland is concerned, has already been outlined by M'Candlish and Kay.[1]

More attention must be given to the selecting of herd sires if the greatest progress in milk production is to be made. There is a clamant need for a complete register of all good sires which will provide the breeders of dairy cattle with a reliable guide to help them in determining the value of the male forebears of any particular bull or cow under consideration for breeding purposes.

Methods of Comparing Sires.—There are many ways in which dairy bulls can be compared so far as their ability as sires of milk-producing cows is concerned. The methods employed at various times may be grouped as follows :—

1. The ideal method could be developed where all records of every daughter of a bull, as well as the records of the dams of those daughters, were known. It is rarely, if ever, possible to get this, so comparisons must be made with less adequate data.

2. The first records of the daughters are sometimes compared with the same records for the dams, or, where the heifer records are not available, records for dam and daughter made at later, but corresponding, ages are used. This is quite a useful method in

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[1] *The Scottish Journal of Agriculture*, vol. xiii., 381–90 (1930).

some circumstances, though it often fails through dam and daughter not having made records at corresponding ages, or through such records not being available.

3. The average records available of the daughters of the bulls are compared without any reference to the production of the dams. This usually gives more daughters through which a comparison of sires can be made, but it has the drawback that some bulls have had a better chance than others on account of their being mated to higher producing cows.

4. Some definite standard is set for the daughters, and only animals which come up to this are included and credited to their sires. The main difficulty here is in setting a standard which will ensure that only good producers are included, and yet not put at a disadvantage bulls which might have proved themselves good but never had a chance.

5. Some mathematical index is determined from the production of the daughters, and perhaps that of their dams as well, and this factor is taken as representing the value of the bull. Variations in the indices are supposed to represent differences in the values of the bulls. These indices may be all right theoretically, but practically they may be misleading, and, in addition, they are usually difficult to obtain.

Material used in this Investigation.—Though milk recording was instituted in Scotland in 1903, it was not until 1917 that the practice was adopted of publishing the names and records of individual animals which had reached a given standard of production. Consequently it is only from that time onwards that published records are available on which to determine the relative merits of the sires used.

The animals were then divided into three groups, namely, Classes I, II, and III, on the basis of their production. In 1917 the standard set for Class I animals was 250 lb. butter-fat per lactation in the case of cows, and 200 lb. in the case of heifers with their first calf. Class III animals were those giving less than two-thirds of these amounts—that is, less than 166 lb. in the case of cows, and less than 133 lb. in the case of heifers. Class II animals were the intermediate group. The records of only the Class I animals were published.

In 1924 it was felt that, owing to the general increase in the level of production which had been brought about, and the greater number of animals eligible for inclusion in the published lists, a still higher standard than that in use should be set. Consequently, though the requirements for Classes I, II, and III were retained unaltered, it was decided that the names and records of only such animals as had reached the level of production equivalent to 280 lb. of butter-fat per lactation in the case of cows, and 224 lb. in the case of first calf heifers should be published.

At the same time another change in the requirements for publication was introduced. Previously there was no limit set on the time that could elapse between calvings. Now, however, it is made a condition of publication that the calving following the record to be published should occur not later than fifteen months after the calving at the start of the record.

Methods employed.—Various opinions exist as to when a sire may be looked upon as "proven," but after much consideration the writers decided that a proven sire should be one with ten or more high-producing daughters. Cows which have produced over 280 lb. butter-fat, or as heifers 224 lb. butter-fat, in a lactation not exceeding fifty-two weeks and calved again within fifteen months, were looked on as high-producers. These butter-fat requirements correspond to yields of 800 gallons of milk at 3·5 per cent. butter-fat in the case of cows, and 640 gallons of milk of the same quality in the case of heifers.

The methods finally adopted when preparing the list of proven sires given herewith can be discussed briefly. First of all it was decided that a uniform standard of production should be used throughout. Consequently, from the reports for the years 1917 to 1923, all animals failing to meet the new butter-fat or calving requirements were eliminated. Then from all reports lactations exceeding fifty-two weeks were discarded.

The records published by the Scottish Milk Records Association include both pedigreed and unpedigreed animals, but owing to the impossibility of tracing the breeding of unregistered animals, or of tracing their records from year to year, only those entered in a breed association herd-book were studied. Even in the case of some pedigreed animals the name and herd-book number were given in such incomplete form that the animal could not be identified in the reports of the Milk Records Association. The records of these animals were discarded. It was felt that before the whole of this work was published it would be well if a fair sample of it could be issued, so that an opportunity might be had of benefiting in the later part of the work by any criticisms which might be offered.

Animals of various breeds are included in the published lists of the Scottish Milk Records Association, but it was decided that the Ayrshire and British-Friesian records, being in the majority, should be worked out first. The published records are grouped under the name of the owner of the herd in which they were made, and the herd owners are arranged alphabetically in the reports.

When these factors were taken into consideration it was decided that, for this paper, all herds belonging to owners whose names started with A or B would be used. From this group the records of all Ayrshire and British-Friesian cows and heifers meeting the set requirements at any time during the years 1917 to 1931 were taken.

Results.—A general idea of the results is given in Table I. The bulls belonging to the two breeds studied are grouped according to the numbers of high-producing daughters they were found to have. Of a total of 812 Ayrshire bulls, 46 had 10 or more such daughters, and so were eligible for entry in the list of proven sires, while 5 of the 160 British-Friesian bulls were also eligible.

TABLE I

Number of Bulls with High-yielding Daughters

No. of Daughters	No. of Bulls	
	Ayrshire	British-Friesian
1–9	766	155
10–19	31	5
20–29	11	..
30–39	2	..
40–49	1	..
50	1	..
Total .	812	160

It will be found as the work progresses that some of these bulls will be credited with still greater numbers of daughters, for the simple reason that many will either have been used in, or have had daughters in, herds which have not yet been reached in this study. For the same reason bulls which have been met with in the herds so far studied, but which have failed to be listed as proven sires, will be found later to come into this group.

It is a fact of some interest that no one man can be given credit for the breeding of any large number of the bulls so far listed as proven sires. These have come from many of the herds studied and also from herds not yet reached.

In the register of proven sires the names of the bulls are given in alphabetical order, along with their herd-book numbers, and also a figure denoting the number of high-producing daughters sired by each.

A Partial List of Proven Ayrshire Sires in Scotland

Name	Herd-Book No.	No. of Daughters
Aitkenbar Magnet . . .	21507	11
Auchenbrain Beneficence . .	18449	16
Auchenbrain Milkman . .	16946	21
Auchencloigh Napoleon . .	11500	24
Auchtool Top Knot . . .	9779	10
Barr High Degree . . .	24537	16
Beuchan Golden Gift . .	9561	10
Beuchan Toddle Ben . .	9530	17
Birnieknowe Bold Boy . .	13494	10

Name	Herd-Book No.	No. of Daughters
Burn Bell Founder . .	21981	11
Campbelton Favourite . .	11027	29
Carnell Perfection . . .	24629	11
Catlins Bright Boy . . .	16263	14
Cawhillan Scottish Favourite .	9052	11
Chapmanton Litigant . .	23558	15
Chapmanton Masterpiece . .	18556	26
Douglas Hall Speculation . .	18566	11
Drum Star	8250	13
Eglinton Mains White Knight .	10126	11
Foulton Night Hawk . .	10722	24
Garclaugh Marksman . .	19786	24
Gerranton Envy Me . .	13329	15
Harleyholm Scott . . .	8724	12
Hobsland Finalist . . .	25219	11
Hobsland Governor . . .	17178	15
Hobsland Lucky Boy . .	16482	40
Hobsland Scotland's Best . .	15103	13
Hobsland Star of Fame . .	23395	11
Howie's High Merit . . .	17894	11
Howie's Pilot. . . .	14088	24
Howie's Sunburst . . .	14096	12
Isles Sir Mark	23467	30
Killoch Capital . . .	21480	11
Kirkchrist Rab . . .	20121	25
Langbarns Nipper . . .	13672	15
Lessnessock Cockayne . .	16019	12
Lessnessock Replica . . .	22955	28
Mainhill Sir John . . .	9776	12
Midtown Masterpiece . .	24068	11
Netherhall Sunstar . . .	13213	15
Netherhall Topmost . . .	18732	20
Sandhill Dividend . . .	15908	50
Sandhill Late Arrival . .	18499	14
Straith Lucky Star . . .	16506	21
Thornhill Blood Royal . .	19485	37
Trees Freemason . . .	9813	11

A Partial List of Proven British-Friesian Sires in Scotland

Name	Herd-Book No.	No. of Daughters
Cradlehall Prince Royal . .	6129	12
Findlay Jordan . . .	11655	11
Findlay Mikado . . .	25707	10
Moss Admiral . . .	6727	10
Tyneside (Imp.) Janus . .	4591	19

INSECT PESTS.—No. XVII

R. STEWART MACDOUGALL, M.A., D.Sc., LL.D.

AT the conclusion of the article in the October number of the *Journal* an example of a typical life history of an Aphid was given, where the Aphid was not a migrating species, but completed its life cycle on one or it might be on related plants. I would emphasise again some great features in the life history of Aphids, viz., how, for a prolonged period of the year, no males are present, and yet the virgin females are able to produce generation after generation of young; and that these young forms are not hatched from eggs laid on the outside, but are born alive, miniature replicas of the parent, the young feeding, growing, moulting, until by a fortnight to three weeks, each, in turn, is producing live young.

Now and again, the Aphids of Cabbage and Turnip (a number of cruciferous crop-plants and weeds can act as host plants), when weather conditions favour them and their enemies are not in strong number, appear especially towards autumn in numbers only describable as a plague; they may swarm into town, settling on people and darkening windows which have to be swept clear. When, in addition, the food plants are retarded and suffering from unfavourable weather conditions, acres of crops may be ruined.

The sexual individuals in an Aphid life-cycle generally appear late in the season, in autumn. The males are small, and as a rule have well-developed wings (sometimes the male is wingless) and long antennæ. The sexual females are also small in comparison with the corresponding virgin females, and as a rule are wingless. In general, Aphid eggs—the fertilised eggs—tend to darken as the days pass, brown or shiny black being very common colours. Eggs may be laid on bud, or leaf, or stem, or branch, and in the case of underground species, on tuber and on root.

The Turnip Aphis described in the October number of the *Journal* has a number of food plants outside the Order Cruciferæ, *e.g.* Rosaceæ, Solanaceæ, Compositæ, Umbelliferæ. Fertilised eggs may be laid in late autumn on Rosaceous shrubs, and a winged generation may migrate in summer to herbaceous Cruciferæ with a return to Rosaceous shrubs in autumn. The Pea Aphis or Green Pea Louse (*Macrosiphum pisi*) is an example of a species which can complete its cycle on various leguminous plants. It attacks pea, bean, clover, lucerne, vetch, etc. This species may pass the whole year on a leguminous plant of perennial character, or may migrate to these from pea and bean to spend the winter. This species is further interesting because wingless females may tide the Aphid over the winter, or the winter may be passed in the egg stage. Some of the males are winged and others wingless.

Whether an Aphid is a non-migrating species or a migrating species there is in the complete life-cycle a sexual stage and a viviparous, non-sexual stage. Where there is a definite migration it may be from a shrub or tree to a herbaceous plant and back again, or from a tree to the roots of a herbaceous plant, or from tree to tree in the world of fruit-growing and forestry. In such cases it is customary to speak of the plant on which the eggs (fertilised) are laid as the primary host and the other as the intermediate host. There is great variation in complexity of migration and life cycle. The Phylloxera and Chermes Section is outwith the purpose of this article, but it may be stated that in Chermes there are two host trees, the primary one a spruce and the intermediate host a pine or larch or silver fir. There are five separate generations, one of them sexual, the other four consisting of virgin females, which (unlike the section of Aphids we are considering) lay eggs which, though not fertilised, yet hatch. The complete life cycle takes two years to complete.

One of the Currant Aphids (*Capitophorus ribis*) migrates in summer to various labiate weeds with a return to the currant in autumn for the sexual forms, but experimentally it has been shown that the sexual stage may also occur on the labiate host. The Mealy Plum Aphis has its sexual stages on plum, and the summer migrant generations fly to reeds.

A species on the leaves of elm passes to the roots of currant, while another migrates to the roots of grasses. The change of host and the possible great variety of host plant greatly add to the difficulties of control. Here, for example, is the story of

The Euonymus—Bean Aphis (*Aphis rumicis*), known also as the Collier and Black Fly. The host plants belong to more than a dozen different Natural Orders, although this Aphis chiefly presses itself on our notice as an enemy of garden and field beans. Summer hosts of this Aphid include bean, poppy, thistle, rhubarb, docken, marigold, beet, turnip.

Fertilised eggs laid on the spindle-tree (*Euonymus*) overwinter and hatch in April, the young developing into the generation known as the Foundress generation—an exclusively female generation. The adult foundress gives rise by virgin birth to a new generation, the members of which, when full grown, are winged. These are all females ; they leave the spindle-tree and fly to bean or other intermediate host. This migrant generation gives rise, on bean, to a new generation of females, and these to others, until winged forms appear among the wingless. These winged females spread the infection to other beans, poppies, etc., where there may be more elbow room, and so on during summer. As the colder weather comes on a generation of males is reared, and of winged females which fly to the spindle-tree. On the spindle-tree the winged females give rise to a generation of wingless true sexual females. Pairing takes place ; the eggs overwinter to give rise in due course to the Foundress generation.

But the sexual generation on the primary host, spindle-tree, may, for a time at least, be cut out of the cycle, because, as Theobald and Davidson showed, virgin females may continue to persist on the bean or other intermediate host, may overwinter on these, and then continue to multiply early in the next season, when their possible food plants come into favourable condition.

There are still further complexities, for true sexual females have been found laying eggs on haricot beans, on dockens, and on sugar-beet, although these three plants are not normally primary, but secondary hosts.

How Aphids are harmful to Plants.—The sap is drained away by the piercing and sucking mouth-parts of the insects so that buds are spoiled, leaves curl and wither, stem and root wilt or show galls and canker-like wounds. The mouth-parts cause a certain rupture of the tissue, and they may penetrate right to the vascular bundles; the breaking-down of tissue is aided by the digestive and dissolving action of the insect's saliva, which is passed into the wound. Injurious bacteria or fungi may gain entry to the plant by way of the Aphis punctures.

The excrementitious honey-dew clogs the stomata and prevents normal and necessary gaseous interchange. Further, as Smith and others have shown, Aphids play a very harmful part (along with other insects that have piercing and sucking mouth parts) in spreading and inoculating virus diseases of potato and other plants.

Control of Aphids.—The insects are soft-bodied and practically defenceless against enemies, although the wax secreted by some of them may give a little protection. They have many enemies apart from unfavourable weather conditions : ladybirds and their larvæ ; the maggots of hover flies ; the jawed larvæ of the lace-wings ; some Cecidomyid larvæ ; some mites ; some capsid bugs.

Hymenopterous parasites act as a great check upon Aphid multiplication. Certain birds devour Aphids, *e.g.*, swallow, martin, tits, chaffinches, sparrows. In two cases noted, the sparrows in their greedy feeding on Rose Aphids and the Mealy Plum Aphis persisted in return, so that in both cases shoots were spoiled by being bent with the weight of the feeding and returning sparrows. Bats also are enemies of Aphids ; a dissected bat was found to have engulfed many hundreds of the Green Spruce Aphis.

The fungi *Empusa aphidis* and *Empusa fresenii* also spoil whole colonies of Aphids, but unfortunately when their worst work has been done. To all these enemies, the Aphids oppose their amazing powers of reproduction and multiplication.

Sprays.—Aphids are very easy to kill, but they must be attacked early : one can do little or nothing on a field scale in face of a plague. Stomach poisons are wasted against Aphids, whose mouth parts are sucking below the surface of leaf or shoot. The insecticide used should be a contact insecticide, one that will plug up the external breathing pores or penetrate them. Such sprays as soft soap and water, 5 to 10 lb. soap to 100 gallons water ; paraffin emulsion, *e.g.* paraffin 2 pints, soft soap 1 lb., water 10 gallons;

quassia—an extract of 6 to 8 lb. of quassia chips—added to 100 gallons of water; nicotine (there is nothing more effective), 95 to 98 per cent., ¾ oz., soft soap ½ to 1 lb., water 10 gallons.

JUMPING PLANT LICE (*Psyllidæ*)

The insects of this family come near the Aphids and are sometimes confused with them. They differ, however, in (1) the femora (thighs) of the hind legs are thickened more than the femora of the other legs; (2) the antennæ are 9 to 10 jointed, and the last joint has two fine end-bristles; (3) the wings are transparent and have thick veins.

The adults are very active, flying and leaping among the branches. Their mode of feeding resembles that of Aphids. The best known and most destructive species in Britain is the Apple Sucker (*Psylla mali*). The damage is done by the young forms, which are destructive to buds, chiefly the blossom buds but also the leaf buds.

The adult is greenish with yellow legs, but the colour is variable, according to the sex and the season. Eggs are laid in autumn. The winter is passed in the egg-stage. Hatching takes place about the time of the bursting of the buds. The tiny young creep into the buds between the leaves, which they pierce and suck. The young are more or less hidden between the young leaves and give out waxy threads; they feed and grow and moult, wing-pads begin to show, and soon the adult stage is attained. As the buds open, the young seek the base of the flower-stalks, and these being punctured the blossom is shrivelled and destroyed, looking as if it had been frosted.

THE MEALY WINGS OR SNOWY FLIES (*Aleyrodidæ*)

This family also comes near the Aphids, but the legs are short, the wings are not transparent but white and opaque, and the body is covered with a white mealy or waxy powder; male and female, each with four wings.

The mouth parts resemble, in general structure, those described for Aphids, and the damage done by the Aleyrodids is similar to Aphid damage, viz., rupture of tissue, draining away of sap and clogging of the breathing and transpiring pores, by exuded honeydew.

Two species are referred to in our literature, viz., *Aleyrodes brassicæ*, which out-of-doors in the South of England has now and again proved harmful to cabbage and allied plants, and *Aleyrodes* (*Asterochiton*) *vaporarium*, the Greenhouse White Fly, well-known in Scotland and England for its destructive work on tomatoes. Not infrequently I receive requests for information regarding this species, and I give a few notes on it here.[1]

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[1] Growers of tomatoes and other plants under glass should consult "The Control of the Greenhouse White Fly, with Notes on its Biology," by Dr Ll. Lloyd, in *The Annals of Applied Biology*, vol. ix, No. 1, and also *Leaflet* 86 *of the Ministry of Agriculture and Fisheries*.

The adults have the appearance of tiny white moths; they are found not only indoors in heated greenhouses, but also out of doors in cold frames and in the open air. In the South of England they can survive a mild winter in the open.

The females lay their eggs in circles or in partial circles, or more or less scattered on the under sides of leaves; a feature of the egg is a short stalk near one end which, caught in a cut in the leaf, holds the egg in position; the eggs are dusted over with wax from the body of the parent. How long the egg takes to hatch depends partly on the temperature, varying from a fortnight in a heated tomato-house to it may be four months out-of-doors. A six-legged larva hatches out, able to move but not active; moving a little way from the place of hatching, the larva sinks its mouth-bristles in the plant-tissue and proceeds to pump up the sap. The larva grows and two moults take place; a third moult follows, and the insect is now covered with a secretion of wax, the piercing mouth parts being visible through an opening on the under surface. Under this covering of wax the insect attains its adult flying stage. The insect feeds in all stages of its development, the time for development of the adult from the hatching of the egg varying, according to the conditions, from three weeks to double this time. The wide range of food plants is seen from Dr Lloyd's list: tomato, potato, cucumber, vegetable marrow, French beans, tobacco, hollyhock, calceolaria, dahlia, heliotrope, stinging nettle; there are additional but less favoured plants. The higher temperature of a cucumber-house disfavours the insect.

If, where the White Fly thrives in the open, the grower grows tomatoes only, clearing out his houses in winter and leaving them free of weed and other plants, then infestation will not happen on his plants until the White Fly begins to show activity outside, and enters the houses, say, at the end of May and in June; thus it will be well on in the summer before the insect can be in numbers enough to do much harm. On the other hand, where in the houses there are other plants all the year round, then the White Fly may always, even in the absence of tomatoes, be present in the houses. From these other plants infection passes to the young tomato plants with possibly very unhappy results, as the pest gets an early start and continues to get worse.

Control.—Take care not to introduce the pest on young plants already infested.

Spraying operations against White Fly are not unlikely to fail because the waxy covering prevents the spray fluid from reaching the insect.

In Dr Lloyd's experiments the best results were got from fumigation.

Fumigation with tetrachlorethane vapour:

Tetrachlorethane is a poisonous liquid; it is poured down the centre of the tomato-house in the evening at the rate of half-a-pint

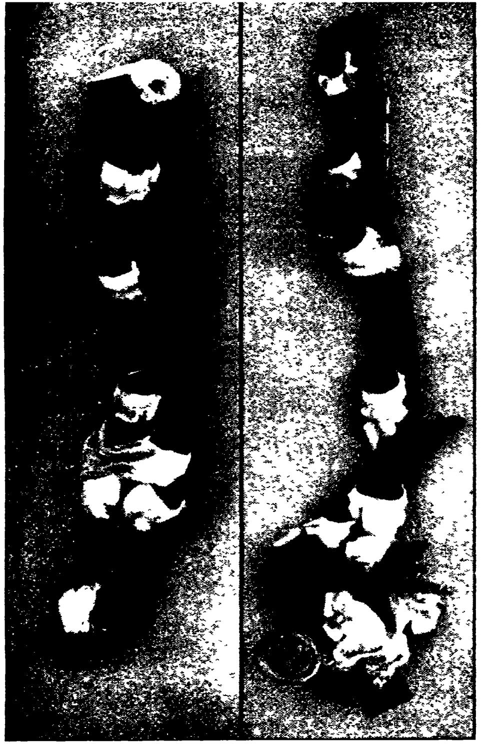

Fig. 1.—White Woolly Currant Scale. From Nature

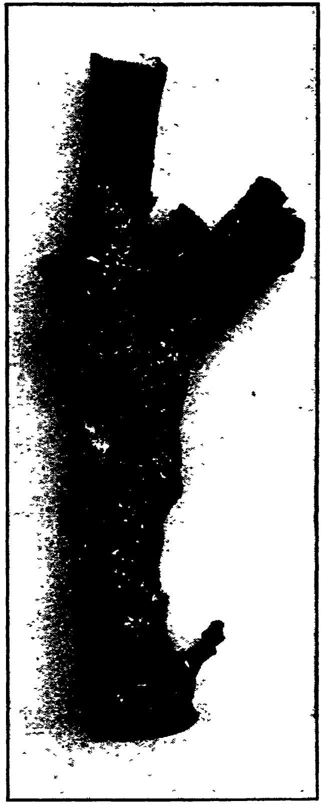

Fig. 2.—Branch of Apple-tree covered with Apple Mussel Scale. Natural size. From Nature

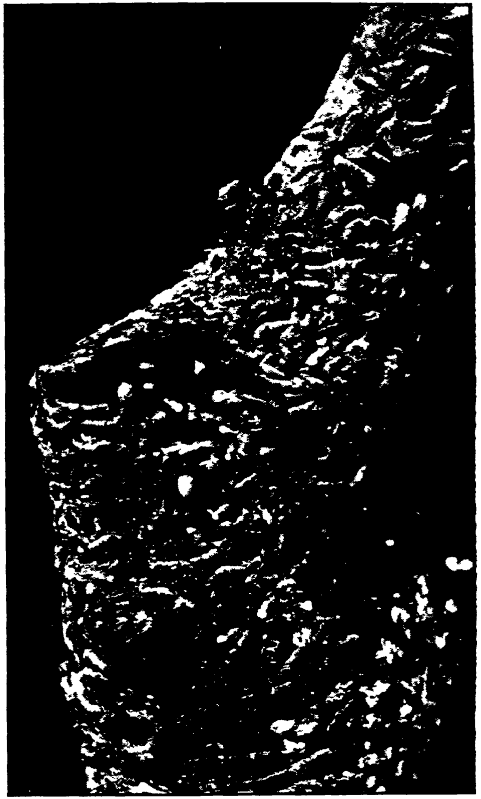

Fig. 3.—Infested branch of Apple, showing the mussel-shaped shields: four times magnified. From Nature

to 1000 cubic feet; the house is then closed, and the longer it can be kept closed the better, at any rate for the next day and night. The tetrachlorethane vaporises and the insects are destroyed. The eggs, however, are resistant and therefore a second fumigation should follow in a fortnight to three weeks. Tetrachlorethane is dear if used on a trade scale. Lloyd in one tomato-house (4500 cubic feet) kept the insect in control, with two fumigations, at an approximate cost of nine shillings. Workers should not remain in houses undergoing fumigation, and the houses should be well ventilated before re-entry. Some plants suffer from the vapour, *e.g.* chrysanthemums, cinerarias, dahlia, pelargonium, primula, azalea, asparagus.

Fumigation with hydrocyanic acid gas: Cyaniding is cheap and effective and is best for trade nurseries. The work requires expert knowledge.[1]

SCALE INSECTS (*Coccidæ*)

Of this family about 150 species have been recorded from Britain, of which more than half are species introduced on plants in commerce and found under glass. There is a very great variety in shape and external appearance; in some the body is covered by a protective shield or scale secreted by skin-glands and supplemented by the cast-off but not thrown-away skins of younger stages; in others the body is convex or dome-like with hard chitin over the upper surface; others have a covering of compact white wax; in one set the female protrudes from the hind end a large white woolly-looking sac which contains the eggs (Fig. 1); the so-called Mealy Bugs have in the males conspicuous long tail-filaments.

Female Scale insects, without exception, are wingless, and the eyes, if present, are never compound. The mouth-parts consist of four long, slender bristles which are guided into the pierced plant-tissue by a short under-lip; sap is sucked away. The legs are short and may be wanting. The males have two wings (some are wingless) and have well-developed antennæ but no mouth-parts; their eyes may be compound.

There is a difference in the development of the two sexes. In the case of the female a larva hatches from the egg followed after two months by two later larval stages and then the adult. The male has two larval stages, a prepupal stage, a pupal or resting stage, and then the adult.

Scale insects are found on stem and leaf and root and fruit. Some notes may be given on a very common scale insect easy to find and easy to observe, viz.:

The Apple Mussel Scale (*Lepidosaphes ulmi*).—This insect is a general feeder with a wide range of food plants. Fig. 2 shows an infested branch of Apple, natural size; Fig. 3 shows the branch under four times magnification. The mussel-like body is not the Scale insect itself, but is a waxy or fibrous shield spun by numerous glands for the protection of the insect; a hand-lens would reveal at the narrow end of each shield one or two moulted skins according to the stage of the insect. To see the insect itself one turns over one of the larger shields. Any time from September or October until the next spring the shrivelled body of the female would be seen (a lens is necessary) towards the narrow end, along with a number of eggs—up to eighty. In June minute six-legged larvæ hatch, and escaping by the hind end of the shield, scatter over the branches. Soon these larvæ settle down, pierce the bark with their mouth-bristles and proceed to pump away the sap. A shield is spun or secreted for protection and a moult takes place; the larva, now in its second stage, is legless and never moves from the place of moult unless destined to be a male. Later another moult takes place, resulting after feeding and growth in the adult female, which becomes sexually mature and ready to pair.

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[1] Those interested in fumigation with hydrocyanic acid gas should read *Advisory Leaflet* 92 *of the Ministry of Agriculture and Fisheries*, and should refer to an article by Sargeant and Edwards in the *Gardener's Chronicle*, vol. lvi, p. 65.

The shields under which males are developed can be told by their smaller size, and by their being not so markedly mussel-like. The developed male is a delicate, active, two-winged insect. The male does not—indeed cannot—feed; his function is to find the female and provide for the future of the race, and therefore it is provided with wings, distinct eyes, a pair of long exploring sensory feelers, and at the hind end a projecting copulatory apparatus. After pairing the males die; the fertilised females proceed to their egg-laying and then die in early autumn. Although functional males are developed the females far outnumber the males, and we get again an interesting case of the hatching of eggs that have not been fertilised (parthenogenesis).

While in the Tropics and Sub-tropics some Scale insects are extremely harmful to fruit trees and fruits, and to coffee and cotton, the out-of-door British species have little importance in agriculture, though several species live at the roots of grasses. British Scale insects have more importance for the forester.

SUB-ORDER HETEROPTERA

We have already defined these as having forewings whose basal half is thickened and tough, while the apical half remains thin and membranous; when at rest the wings lie flat on the back with the membranous tips overlapping.

As with the Scale insects the Heteroptera have far more economic importance abroad, for example, one of them, the notorious Chinch Bug, has done enormous damage to grass-crops in the United States and Canada. Another is a giant water-species measuring over a quarter of a foot long and having a wing-spread of half a foot. In Britain only a few species rank as very harmful, and these chiefly to fruit plants and fruit. There are numerous blood-sucking species, and among them the family Cimicidæ, which numbers in it the unpleasant Bed Bug. There is also a considerable number of interesting aquatic species.

As regards life-history the Heteroptera, like the Homoptera, have an incomplete metamorphosis, the adult stage being attained after a series of moults without any resting pupal stage. There are in general, however, some features characteristic of the adult apart from sexual maturity—for example, the presence of flying wings; sometimes a different number of joints in the antennæ and an increased number of joints in the tarsi (feet). Various families of Heteroptera contain numerous species that are carnivorous in diet, various insects and small animals being pierced by the mouth-parts and then sucked dry.

Several species of the Family Capsidæ have been proved in England serious enemies of fruit and fruit-plants. About 1912 there were numerous complaints as to spoiling of apples. J. C. F. Fryer of the Ministry of Agriculture, Lees of Bristol, Theobald, Smith, Petherbridge and other workers proved *Plesiocoris rugicollis* to be the chief culprit on Apples. The female lays her eggs under the epidermis of the young shoot, the second last year's shoot, or the shoot of the year. The winter is passed in the egg stage; hatching is in the next April or May. The newly hatched young puncture the young leaves, the result being a wilting and a very characteristic brownish-red spotting. A little later the developing bugs attack the fruitlets and also puncture the young shoots. Attacked fruits often fail to develop properly and those that make some growth are misshapen; the best of them are ruined for sale purposes by the spotting and the wrinkled skin. Smith[1] showed that not only is harm done by the wounding of the stabbed tissue by the insect's mouth-parts, but that the cells at the places of puncture are killed by the toxic action of the injected saliva.

More recently workers found that another species (*Lygus pabulinus*) was turning out a serious enemy of fruit. Petherbridge[2] and Thorpe proved it a serious pest of currants, gooseberries, strawberries, potatoes and dahlias, and to be also present in apples, pears, plums, cherries, peaches and a large number of cultivated plants and weeds.

Family Cimicidæ

These—the Bed Bug is a typical species—are blood-sucking parasites of the warm-blooded animals—viz., birds and mammals. Some species prey on pigeons and fowls and others swarm in the nests of birds—*e.g.* swallows and martins. The bat is a host of at least two species. The Bed Bug (*Cimex lectularius*) not only sucks the blood of human beings but also that of such animals as cats, dogs, rats, mice, rabbits, guinea-pigs.

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[1] "Damage to Plant Tissue from Capsid Bugs," by K. M. Smith, in *Annals of Applied Biology*, vol. vii, 1920.

[2] "The Common Green Capsid Bug (*Lygus pabulinus*)," by F. R. Petherbridge and W. H. Thorpe, in *The Annals of Applied Biology*, vol. xv, No. 3, August 1928.

The Bed Bug hides in the daytime and comes out to feed at night. Its daytime shelter-places are cracks and chinks in wood—the crannies and seams and breaks in old wooden bedsteads afforded favouring shelter-places (in superstitious times foxes' tails and rabbits' feet were hung near beds to ward off the bugs)—under cover of broken wallpaper, behind pictures, among books and collections of papers.

After pairing, the female lays her eggs in such places as crevices in wood, seams and floors, etc. A single female in the course of a life of some months may lay over 200 eggs. From the egg hatches a small creature that resembles the adult in external appearance and food habits. It feeds and grows and moults, and after a series of moults the sexually adult stage is attained without any resting pupal stage.

Bugs are resistant to unfavourable conditions and are capable of long fasts ; a fasting period (not prolonged if hosts be available) generally follows a meal. Apart from their blood-sucking habit the Bed Bugs are disgusting from their repulsive odour, this arising from the scent or stink-glands, whose openings to the outside are in the case of the adult on the under side of the fore-body and in the younger stages on the upper surface of the abdomen. (In some other families of Heteroptera there is evidence that the concentrated odour from these glands is distasteful and even harmful to other insects and even to small vertebrate animals.)

Cimex lectularius has been suspected as the carrier of the virus of relapsing fever and a possible carrier of typhus. There is some reason for the belief that the Oriental Bed Bug (*C. rotundatus*) conveys the parasite which is the cause of the tropical disease Kala-azar, common in India.[1]

AQUATIC FAMILIES

Space does not allow more than the naming of some aquatic Heteroptera, the Pond Skaters, the Water Scorpions, the Water Boatmen. The student would find much to interest him in their structure, their habit of life, the way they fit into their environment, their method of movement, their respiration, and the capture of their prey.

GROUND OATS FOR PIGS

T. S. WRIGHT, N.D.A.

Harper Adams Agricultural College, Newport, Shropshire

CONSIDERABLE experimental work has been carried out from various aspects in connection with the marketing of such home-grown crops as potatoes, wheat, separated milk, whey and the like through the medium of the pig, but in view of its importance and wide range of cultivation it is surprising to find that little has been done concerning the feeding of oats to fattening hogs.

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[1] A pamphlet on the Bed Bug by the late Bruce Cummings and Major Austen, full of information as to natural history, remedies for bites and control measures, is obtainable at the British Museum.

Some ten years ago Dr Chas. Crowther and the late Mr W. S. Chalmers, B.Sc., conducted a large-scale experiment on home produced foods, which included one lot of pigs receiving wheat and barley meals and ground oats ; owing to the " unbalanced " nature of the rations necessitated by the character of the experiment the results all round were poor, but those with the ration containing oats were distinctly inferior to those with sharps, a result that the high fibre of oats might explain.

In 1927 an extensive test with oats was organised by the Irish Department of Agriculture,[1] in which, at various centres, two groups of pigs were fed alike on balanced mixtures, except that for one group one part of maize meal was replaced by crushed oats. The final figures were highly satisfactory, the mean total gain in each case being the same, as was also the weight of food required to produce one pound of live weight increase.

In another trial conducted at the Duthie Experimental Stock Farm [2] two different rations, in which the starchy foods were chiefly supplied in the form of crushed oats and cooked potatoes, were compared with a control mixture of barley, fish meal and sharps. One lot received its protein and minerals as separated milk whilst the other was provided with extracted soya bean meal and a mineral mixture ; no significant differences were apparent in the final results, such small differences as existed showing the milk group to slight advantage in all respects including costs, in regard to which the ration with the fish meal was considerably more expensive.

Conclusions drawn from these tests, as well as from many carried out in the United States, agree, almost without exception, that the limiting factor in the economic feeding of oats to swine is the large proportion of crude fibre which for immature stock restricts its use to a maximum of about 30 per cent. of the ration ; further, this food must not be fed whole but as a meal, and as such the finer the better.

More recently [3] Dr Woodman and his colleagues at Cambridge have reported the results of duplicate trials relating to the substitution of ground oats for barley meal and middlings (sharps). The results reveal no significant differences as shown by the daily live weight gains, which in one experiment averaged 1·46 lb. for barley meal and wheat offals, 1·50 lb. for barley meal, ground oats and sharps, and 1·58 lb. for barley meal and ground oats ; the weights of meal consumed per lb. live weight increase being 4·16, 4·20, and 4·04 lb. respectively. From these results the investigators suggest that for practical swine feeding ground oats may be substituted for barley meal and sharps pound for pound, up to as much as 40 per cent. of the ration, but agree that the efficiency of the oat is greatly influenced by the fineness of grinding.

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[1] *Journal of the Department of Agriculture,* Irish Free State, 1927.

[2] *Scottish Journal of Agriculture,* January 1930.

[3] *Journal of Agricultural Science,* July 1932.

In past experiments, for the most part, a fraction of the barley or maize portion of the control ration has been replaced by oats, but in view of their fibre content and bulk the latter would appear to be more comparable with sharps or dried sugar-beet pulp. With the object of testing the possibility of replacing a purchased food (sharps) by a home-grown grain (oats), the writer carried out an experiment at the Harper Adams Pig Feeding Experimental Station, the results of which are summarised in this report.

Details of the Experiment.—*Live Stock.*—For the purposes of the experiment 24 home-bred Large White pigs, all sired by the same boar, were selected and divided carefully into two lots as closely comparable as possible, due regard being paid to sex, breeding, age and weight. The pigs were 11 weeks old at the start, and averaged about 38 lb. each in live weight. Lot I served as the "Sharps Lot" and Lot II as the "Oats Lot." One pig in Lot II soon proved to be quite unsuitable for experimental purposes, and after five or six weeks was removed and its records discarded. The average data for this lot, given later in this report, thus refer to 11 pigs compared to 12 pigs in the Sharps Lot.

Management.—The two lots received similar treatment throughout, being penned as sixes some days prior to the start of the experiment in order to enable the stock to settle down together and become accustomed to the diet. Two feeds were given daily at regular hours, the pigs receiving at each meal just as much as they would clean up. Enough food for twenty-four hours was weighed out separately for each lot daily, and about 9 a.m. was mixed with water to allow ample time for the meals to soak. The proportion of water to meal was fairly wide at first (3 : 1) and gradually narrowed as the pigs grew. A small amount of green food was given each day, and for the sake of their health the pigs were exercised at the same time in small concrete yards for 15 to 30 minutes according to their age.

Rations.—The basal ration for both lots at the start was as follows :

	Per cent.
Barley Meal	10
Tapioca ,,	31
Maize ,,	16
Soya ,,	11
Minerals	2

In addition Lot I received 30 per cent. of sharps and Lot II 30 per cent. of ground oats.

As the result of gradual modification the proportions of the ingredients at the finish were :

	Per cent.
Barley Meal	10
Tapioca ,,	38
Maize ,,	25
Soya ,,	5
Minerals	2

The balance of 20 per cent. was made up by sharps, Lot I, and oats, Lot II, which were reduced from 30 by roughly 2 per cent. per month.

The inclusive costs per cwt. of the above feeding stuffs were :

	s.	d.		s.	d.
Barley Meal	7	10½	Ground Oats	7	9
Tapioca ,,	5	9	Soya Meal	8	0
Maize ,,	5	11¾	Minerals	3	1¾
Sharps	6	5½			

The oats were stone-ground, being run through the mill twice, thus reducing the kernels to a floury state and leaving the husk portion in rather a coarse condition, though definitely not so rough as that of crushed or bruised oats. The material was light and open in texture, which was desirable if it was to fulfil one of the more important functions of sharps—that is, the leavening of the rest of the constituents of the mixture. During the early weeks of feeding the pigs did not care for the oats, and consequently spent considerable time in eating in their endeavour to leave as much of the husk as possible ; this tendency slowly vanished as the animals grew older and the percentage of ground oats was curtailed. Hogs of six months and over showed no objection to the husk even when it was inefficiently ground. Although Lot II did not suffer to any extent from constipation their dung was at all stages distinctly harder than that of Lot I in receipt of sharps ; this was doubtless due to the large amount of crude fibre in the ration. With regard to the general external condition of the two lots, that receiving the oats seemed to possess the better " bloom," and throughout the 25 weeks of feeding it was always the cleaner—the skin had a healthy appearance, being pink-white in colour with almost a complete freedom from dirt. In this respect they were in marked contrast to the sharps pigs except during the last few weeks.

The feeding period was rather prolonged, lasting for 25 weeks, from 19th November 1931 till 10th May 1932. This is not unusual with pigs farrowed in the autumn.

Recording of Weights.—The customary routine of weighing at this Station was maintained for this test, the initial and final live weights of each individual pig being calculated from the mean weighings recorded on three successive mornings, whilst the intermediate weights were taken at weekly intervals after a fast of some 15 hours.

Results.—The following tables show (1) the quantities and costs of foods consumed per pig ; and (2) the summary of average weights :

TABLE I

	Lot I			Lot II		
	lb.	s.	d.	lbs	s.	d.
Barley Meal .	68·1	4	9½	66·3	4	8
Tapioca ,, .	211·5	10	10¼	205·5	10	6¾
Maize ,, .	162·3	8	8	156·3	8	4
Sharps . .	157·6	9	1	..		..
Ground Oats .	..		..	152	10	6¼
Soya Meal .	48·8	3	6	47	3	4¼
Minerals . .	16·8	0	5½	17·5	0	5¾
Totals .	665·1	37	4¼	644·6	37	11
Meal consumed per lb. live weight increase .	3·60 lb.			3·79 lb.		
Cost per lb. live weight increase . . .	2·43d.			2·67d.		

TABLE II

	Lot I	Lot II
	lb.	lb.
Initial weight . .	37·88 (12 pigs)	38·18 (11 pigs)
Gain per week . .	7·47	6·84
Gain for first 16 weeks	101·35	84·06
Total gain . .	184·64	169·88
Final weight . .	222·52	208·06
Fasted weight . .	214·00 (12 pigs)	200·62 (estimated)
Dead weight . .	171·6	162·30 (,,)
Carcass as percentage of Fasted weight .	80 per cent.	80·9 per cent.

Discussion of Results.—With reference to Table I, although the results appear to be satisfactory it cannot be claimed that either lot did well in view of the extended length of feeding. This was caused by poor appetites on the part of the majority of the pigs in the experiment; for some time in the earlier stages they would take only a small quantity of meal per head per day, resulting in low weekly gains. This applied more particularly to Lot II, which, in and after the sixth week, consumed considerably less than Lot I, until the last few weeks when their capacities rapidly developed, so that for the last 14 days they were receiving the same as the latter. These facts are well illustrated by the increases of the two groups. After the first week Lot II slowly lost ground to Lot I until the end of the first 4 months, when the latter averaged 17 lb. more per head, *i.e.* 7 lb. in excess of the experimental error of 10 per cent. From that point the difference tended to lessen by 3 or 4 lb., which more or less coincided with an increase in appetite on the part of the " oat " hogs.

The oats used were purchased from a local mill in order to secure efficient grinding, and this made the food bill for Lot II sevenpence per pig dearer than that of Lot I, but for purposes of the experiment this is of no moment since in practice the charge would be governed by the production costs of the crop on each individual farm.

The figures in Table II show Lot I to distinct advantage, which is further emphasised by the fact that the pigs of this lot were fit for slaughter some 12 or 14 days sooner ; at the end of the experiment all the pigs of Lot I were ready for the butcher, whereas of Lot II only 64 per cent. were available. The carcass percentages for both lots were satisfactory. Detailed records of each pig reveal that the various individual weights of Lot II extend over a wider range than those of Lot I, and that for the most part the pigs of the former, that were originally heavier and more robust, " did " best to a very marked degree. They were, doubtless, through being stronger, able to cope with the large amount of fibre more successfully at an earlier date than the light weights.

Carcasses.—At the end of the test 12 pigs from Lot I and 7 from Lot II were sent to the bacon factory and killed. After cooling, the 19 carcasses were inspected, attention being paid to the condition of the fat and lean, as well as to their relative proportions. No significant differences could be detected between the quality of the two lots, which were uniform throughout : flesh and fat were, on the whole, firm and evenly distributed. Since sharps and oats both contain about 4·8 per cent. of oil, no differential effects of this ingredient upon the bacon-fat were to be expected, and consequently the usual determinations of the iodine values of the bacon-fats were omitted.

Conclusions.—The results of this comparison between sharps and ground oats bear out the expectations based upon the compositions of the two foods. On account of their large crude fibre content, oats should be ground as finely as possible for successful pig feeding, especially for young pigs. For pigs of five months and upwards it is of less consequence. The data obtained from the early weeks of this experiment suggest that it is unwise to include oats at all in any ration for youngsters under 16 weeks, and at no period should they form more than 25 per cent. of the whole ration. The influence of ground oats on the texture of the meals after soaking can be said to be equal to that of sharps, in that they lighten the mass, thereby restricting the " doughy " tendencies of the other foodstuffs.

Briefly, when the sale of home-grown oats is unprofitable, or when supplies are abundant and cheap in comparison with milling offals, they can, if well ground, be substituted for sharps (thirds, coarse middlings, etc.) in fattening rations for pigs over four months old, subject to a maximum of 25 per cent. for stock under seven months old.

Thanks are due to Dr Chas. Crowther for his advice in the conduct of the experiment, and to Messrs Marsh & Baxter, Ltd., of Brierley Hill, for facilities for the weighing and examination of carcasses.

Farming Profits and Losses

IN order to measure the profitableness or otherwise during recent years of the various farming systems practised in Scotland, it is necessary to draw a base line, as it were, from which we can measure the effects of changes in prices. It is convenient to take the year 1928-29 as that base, for it was then that the Department of Agriculture for Scotland commenced to collect records of the financial results of farming, a plan which has since been continued with the collaboration of the Colleges of Agriculture at Aberdeen, Edinburgh and Glasgow.

By 1928-29 farming had by no means adjusted itself to the disproportionate changes in costs and in prices that had taken place during and since the Great War. Costs generally were much greater than in the pre-war period, particularly the cost of labour, though fertilisers were cheap and feeding-stuffs fairly so. Altogether, and for the whole country, the level of costs was about one and a half times as high as it was in 1911-13. On the other hand, the prices of many farm products, including milk and dairy produce, sheep, pigs, poultry and eggs were fairly high too. The products of which the prices in 1928-29 were at levels below the general level of costs were the cereals, oats, barley and wheat, cattle of all kinds and wool. The price of potatoes fluctuates a great deal; in 1928 it was high, in 1929 very low.

As a result of these price conditions the financial situation of farmers in different parts of the country and engaged in different forms of production was by no means equal. It is estimated that the cattle-feeding farmers of the North-East area were only about three-quarters as well off in 1928-29 as they had been just before the war; that the arable farmers of the Eastern counties, producing mainly crops for sale and fat cattle for slaughter, may have been only about half as well off, but that, on the other hand, the dairy farmers of the South-West were rather better off than they had been before the war. The lowland sheep-feeding farmers of the Border area were no worse, if not very much better off, while the farmers breeding sheep on the higher grounds were in a considerably better position than before. There were, of course, great differences as between farmer and farmer, and there were many farmers whose circumstances were intermediate between those of the groups mentioned, but speaking in broad terms the comparative positions of the farming systems characteristic of the agriculture of Scotland were as described.

What has happened since ? In the year 1929-30 the price level of agricultural produce generally fell, but not very much. Similarly agricultural wages fell a little, feeding stuffs were much cheaper and fertilisers only a little dearer. But as between one type of farm produce and another the changes in prices were much greater. The values of the cereal crops fell heavily; potatoes, which were a very large crop in 1929, realised very low prices indeed, and much of the crop remained unsold. For live stock, on the other hand, there was a slight gain in prices, which was most marked in the case of pigs. The price of milk was maintained, but cheese and wool fell considerably in value.

The effects upon the fortunes of the farmers were correspondingly various. Among the cattle-feeding farmers in the North-East of Scotland, most of whom sell an appreciable amount of crops as well as fat stock, there were some who did better than in the previous year, but probably twice as many who fared worse, and some precision may be given to their financial position by saying that in 1929-30, of all the farmers of the North-East who made their accounts available to the Department of Agriculture, only some 42 per cent. made incomes of sufficient amount to support the farm household with or without a margin for savings, and only about 32 per cent. may have had reason to be satisfied with the results of their year's work, having regard to the amount of their capital used.

The arable farmers of the Eastern area had been doing badly enough in 1928-29, but in 1929-30 the situation became distinctly worse. Some of the more favourably situated farmers managed to improve their positions, but very many more fared worse than in the previous year, and it is melancholy to record that only 25 per cent. of the farmers whose accounts were received at the Department may have achieved a livelihood on the year's working, often with little or no margin for savings, and a very small proportion could be said to have done reasonably well having regard to their abilities as managers of businesses of considerable size.

In the Border area in 1929-30 there was a more even balance in numbers between farmers who fared better and farmers who did not do so well as in the previous year, and probably profits were rather better on the whole. But a none too satisfactory situation can be inferred from this. Difficulties were great on the lower farms where sheep and cattle are fed for killing, but on the higher-lying farms the position was better, and there is little evidence in the accounts received that the hill farmers were otherwise than reasonably prosperous.

Apart from the hill sheep farms, the milk-selling farms of the South-West seem to have maintained their position in 1929-30 better than any other type, but the cheese-making farms were in general badly hit owing to the heavy fall in cheese prices. Of all the dairy farmers sending in returns to the Department about two-thirds may have made a living or something better, and about

40 per cent. of the farmers may have had reason to be content with their gains.

To sum up the situation in 1929-30 broadly, whilst a minor proportion of farmers had improved their position since the previous year, the average level of profits had fallen, and in those areas where conditions had already been bad in 1928-29, viz., in the Eastern arable and feeding counties generally, they had still further deteriorated.

We may now step forward another twelve months, viz., to 1930-31, bringing our review up to a period ending about a year ago. This year saw a further fall in agricultural prices generally, the mean price level for the period being about 25 per cent. above pre-war. It is interesting to observe that although this represented a considerable falling off since 1929-30 and a still greater falling off since our base year, 1928-29, the general level of British agricultural prices was still considerably higher than the wholesale price level of produce in general, which had declined in 1930-31 to a point very little above pre-war. This is of importance in view of what has happened since, giving rise to the crisis through which the industry is now passing, for it meant that for reasons which it is not necessary to go into now, British agriculture, in some of its aspects, did not at first meet the full force of the new phase of the world depression in prices that made itself manifest from about the beginning of 1930. But this does not apply all round, for the prices of cereals, and especially of wheat and oats, and also of wool, fell during 1931 to much below pre-war levels. The prices of cattle, however, held fairly well at about 25 per cent. above pre-war, and although sheep and pigs fell somewhat from their high estate they were still much dearer than pre-war and dearer too than cattle. The really bright spots were potatoes, which were short in supply and rose to a very high price, and milk, which had consistently held its price better than any other product of importance; but cheese dropped seriously in value. Costs were just a little easier, as feeding stuffs were cheap in sympathy with the low prices of grain.

How did Scottish farmers fare in this welter of change and uncertainty? On the whole badly indeed. The cattle-feeding farmers of the North-East, who were doing none too well in our starting year, 1928-29, in comparison with their pre-war position, and whose situation in 1929-30 was that probably less than half of them were making ends meet, got even deeper into depression. Of those whose accounts for two consecutive years have been examined, five out of every six had a worse year in 1930-31 than in 1929-30, and of all the records examined by the Department from that area nearly two-thirds revealed actual losses, which are really net losses, since no charge has been made in the accounts for the farmer's work and maintenance.

In the Eastern arable districts the better prices for potatoes of the 1930 crop brought some measure of relief, and farmers who did better in 1930-31 than in the previous year may have been greater in number than those who fared worse. But this represented only a minor alleviation of the very unhappy position in this area, and even the relief afforded still left probably quite half of the farmers with actual losses on the year's working.

In the Border area the falling values of sheep had a marked effect upon farm profits. The Department's records show that for every farmer who may have managed to maintain his position at least ten fared worse than in the previous year; and although some of the higher land farms managed to make profits, losses were much commoner on the lower lands, and fairly general on the most highly rented grounds.

Even among the dairy farmers of the South-West profits generally were on a lower level; and while the percentage of cases in which actual loss occurred was small on the milk-selling farms, there was probably a high percentage of the cheese-selling farms which failed to make ends meet.

This brings us to the year 1931-32, for which period accounts are not yet available to the Department in sufficient numbers to speak in any numerical terms of losses and gains. But the index numbers of the course of prices are sufficient for our present purpose. Since the autumn of 1931 cereal prices have shown little change except that there has been some small improvement in the price of oats. It is in the all-important realm of live-stock prices, however, that a serious falling away has manifested itself, bringing the average level of agricultural prices more closely into line with the general price level. For the stock breeders of Scotland sheep are of primary importance. The prices of store sheep had actually risen during 1930 while prices generally were falling, but by December 1931 they had lost this advantage, and during 1932 they have sunk to figures far below pre-war. In fact, in October 1932 they have been at not much more than 55-60 per cent. of their value in November 1930. Thus the sheet-anchor, as it were, of the Scottish live stock breeding industry has at last given way, and in parallel case the prices of fat sheep have fallen too, leaving the farmers who feed the sheep to maturity without any advantage from the fall in value of the store sheep they buy to feed.

The output of the breeding farms in the form of young store cattle did not share the latest general fall in world prices until the end of 1930, but store cattle have since been drawn into the vortex, though with less severity than in the case of sheep.

To the feeders of live stock cattle are of first importance, and here it has to be recorded that, in the case of fat cattle for slaughter, a parallel, but somewhat more serious, fall in prices than occurred in the case of unfinished cattle has taken place. This has reduced the margin of returns to the feeder, in spite of the lower costs of the store animals he buys.

Since sheep rearing, which was, up to the end of 1930, holding up its head, has at last succumbed to this insidious and widespread depression, dairying remains the only branch of agriculture which may be said to be holding its own, though it has been unable to maintain the small gains over its pre-war returns which were recorded in 1928-29. Milk prices were somewhat lower in 1932 than in the previous year, but fortunately cheese prices were better. The farmers of the arable lands of the East received a good deal of help from the short potato crop of 1931 and the very good prices realised from its disposal, but, as if to counter even this piece of good fortune, a large crop of 1932 has succeeded, bringing with it a return to prices reminiscent of the tragic potato year of 1929.

If our reading of the situation is a true one, and farmers are, in common with the rest of the world, the victims of a vicious cycle of causes that have, in spite of the nearness of the great home market, caused prices to fall with such violence that no practicable and immediate adjustment of costs can serve to redress the balance, then it is from those actions which will tend to put the whole world on the highway to renewed prosperity that lasting and substantial relief must come.

The Musk Rat

THE Destructive Imported Animals Act, 1932, the object of which is to control the importation or keeping of musk rats, and to take effective action for exterminating any such animals which may be at large in this country, was passed into law on 17th March 1932. Under this Act, the Secretary of State for Scotland and the Minister of Agriculture and Fisheries are empowered to prohibit by order the importation and keeping of musk rats in Great Britain, except under licence. This power has been exercised by means of the Musk Rats (Importation and Keeping) Order, 1932, which came into operation on 1st May 1932. As from that date musk rats may be kept only under licence, the general conditions of which are set forth in the Musk Rat (Importation and Keeping) Regulations, 1932. In terms of the statute, occupiers of land on which musk rats are at large are required under penalty to give notice forthwith to the Department, who may take such steps as they consider necessary for their destruction.

Through the medium of the Press, by the extensive distribution of pamphlets and posters and by communication with Local Authorities, Agricultural Associations, and landowners in selected areas, the Department have taken steps to secure wide publicity for the provisions of the statute, and they have invited the co-operation of those bodies and of members of the public in assisting them to discover the presence of musk rats in any locality, and if possible to kill them. The Police have been requested by the Secretary of State to report to the Department all cases where the presence of musk rats at large is known or suspected. The seriously infested area in Scotland is in the vicinity of Carsebreck Loch, where a trapper, employed by the Department, has been at work since the month of October. Another trapper is engaged in the neighbourhood of the junction of the rivers Allan, Forth and Teith, where musk rats are known to be at large. The animals have also been discovered at Forgandenny in a backwater of the river Earn; this area is being kept under observation.

The Department are taking special action in regard to a loch and contiguous marshy area extending to about 16 acres in central Perthshire, the occupier of which had established about three years ago a ranch for breeding purposes. The area is known to harbour a considerable number of musk rats. It was considered essential in the public interest to take steps to prevent the escape of the animals when trapping operations on an intensive scale are commenced. This is to be effected by the erection of a musquash-proof fence, the construction of which is practically completed.

The Department are actively pursuing their inquiries both through Local Authorities and other bodies and by means of personal inspections of land. Despite careful investigation, however, they have no evidence meantime that musquash are at large in Scotland outside the counties of Perth and Stirling.

The Journal, for November 1932, of the Ministry of Agriculture and Fisheries contains an interesting article based upon a report by Mr M. A. C. Hinton, Deputy Keeper of Zoology at the British Museum, and Mr E. C. Read, Technical Adviser to the Ministry on Rat Destruction, who attended the German State Conference on musk-rat control in June 1932.

In Germany musk rats are reported to be widely distributed, the number destroyed in four States in 1930 being 30,222. Eastern Bavaria, nearly the whole of Saxony, and large parts of Thuringia, Prussia and Silesia are so seriously infested that remedial action is necessarily confined to the thinning down of the existing musk-rat population and the protection of such important structures as the Rhine-Danube Canal and the Great Saale Dam. Considering Germany as a whole, however, the measures adopted are believed to be reducing considerably the numbers of musk rats at large, and to be curtailing the rate of invasion of new territory.

The keeping of musk rats by private individuals is now prohibited in Germany, while the interest of the general public in the work of eradication is fostered and sustained by a continuous campaign of publicity and the offering of rewards to private persons for musk rats destroyed. Official musk-rat destroyers are employed in all the principal States.

The article gives an interesting description of some of the methods used by the chief Bavarian trapper, whom the reporters saw at work near to Saale in the Danube valley.

The Use of Derris against the Sheep Tick

THE following article is contributed by J. MacLeod, B.Sc., Ph.D., Moredun Institute, Gilmerton, Edinburgh:—

In the spring of 1930 a number of experiments designed to test the value of arsenic and carbolic dips against the sheep tick, *Ixodes ricinus*, was carried out on a tick-infested farm. The results of these experiments indicated that both arsenic dip at a "bath-strength" of 0·16 per cent. As_2O_3, and carbolic dip at a "bath-strength" of 0·35 per cent. phenol, killed the majority of attached ticks, provided the process of dipping were properly carried out.

It was found, however, that neither preparation could be relied upon to kill all the ticks attached to the sheep, however carefully they were dipped.

It was therefore decided to test the value of Derris. This is a genus of tropical plants indigenous to Malaya and other Eastern countries. Some of the species contain a toxic principle, the chemical nature of which is unknown, but which is present in a resin extracted from the root. The powdered root has long been known to possess insecticidal properties, and in 1924 it was introduced to veterinary practice as an acaricide by Professor J. Russell Greig.

In the spring of 1931 experiments were designed to test its efficacy when prepared in the form of a dip. For these experiments a powder of the derris plant was prepared, the percentage resin, or toxic extract, of which was estimated so that a bath could be prepared which would contain a definite concentration of the active principle.

Experiment 1.—To test the comparative efficacy of arsenic, carbolic, and derris dips.

Twelve Cheviot hoggs were taken off the hill on a tick-infested farm. Four of these were dipped in an arsenical, four in a carbolic, and four in a derris dip.

The dip solutions were made to the following standards:—

	Per cent.
Arsenic . . .	0·2 As_2O_3
Carbolic . . .	0·35 Phenol
Derris . . .	0·21 Toxic Extract

A suspension of the derris powder in water was made, and to this a solution of soap was added. The sheep were given a thorough immersion for one-half minute in a bath. They were examined daily on each of the following three days.

Examination after 24 and after 48 hours revealed ticks still surviving on all three groups, the greatest number being found on the group dipped in the carbolic solution.

On the third day there was still a number of ticks alive on the

" carbolic dip " group. Only one gorged female was found alive on the " arsenic dip " group. The " derris dip " group appeared to have no surviving ticks.

A number of ticks which had attached since the process of dipping was now found on all three groups, so further observation was discontinued.

This experiment suggests that derris is quite as efficacious as the usual carbolic and arsenic dips in effecting tick destruction. For a series of short interval dippings, such as might be carried out for the purpose of tick-control, it has the advantage that the sheep can be repeatedly dipped at short intervals without suffering serious ill effects such as are associated with the repeated use of carbolic or arsenic dips.

There are two objections to the use of a derris dip prepared as described above. Two separate solutions require to be prepared, one of the derris powder and one of the soap powder. Further, derris in solution does not long retain its parasiticidal properties, and, if a series of dippings at short intervals is being carried out, new solutions require to be prepared fairly frequently.

Experiment 2.—(*a*) To test if derris solution retains its parasiticidal property for a period of four days.

(*b*) To test if a solution prepared from a mixture of derris and soap powder forms a satisfactory " tick dip."

The combined soap and derris powder was mixed with the requisite quantity of water and allowed to stand. Four days later a second bath of the powder was prepared.

Five hoggs and one lamb were dipped in the old dip and five hoggs and a lamb in the fresh dip. Each sheep was immersed for one-half minute in a bath.

After 48 hours a number of ticks was found surviving on both groups of sheep.

The following day—that is, three days after dipping—there were a few nymphs living on the " old derris " group. All the females and larvæ were dead. On the " fresh derris " group there were no living ticks..

These preliminary field experiments require amplification, but the results obtained suggest the following conclusions :—

(1) Derris at a bath-strength of 0·21 per cent. toxic extract, when mixed with a soap solution, forms a highly satisfactory tick dip.

(2) A solution prepared from a mixture of derris and soap powder forms an equally satisfactory dip.

(3) Derris dip solution retains to a great extent its properties in the bath for a period of at least four days.

(4) The four days' old dip is not so efficacious as fresh dip, but appears to be practically as destructive to ticks as are fresh solutions of arsenic or carbolic dips.

(5) Derris should form a satisfactory dip for serial dippings of sheep against ticks. The bath would require to be renewed after every two dippings.

The dips used in the above experiments were kindly supplied by Robert Young & Co., of Glasgow, at whose suggestion derris was tested as a sheep dip.

The experiments were carried out at Gilmanscleuch, Ettrick, by courtesy of Mr Andrew Linton, who supplied the sheep and the facilities for dipping and handling.

Methods of Castration of Lambs

THE following article has been contributed by Dr A. H. H. Fraser, Duthie Experimental Stock Farm, Rowett Institute, Aberdeen:—

The two methods of castration of male sheep are the knife and the bloodless castrator. There are various minor modifications of the knife method, but the essential fact is that both testicles are removed, unless one or both are undescended. In the method of bloodless castration the spermatic cord is crushed, and the testicle slowly degenerates. The main advantage of the knife method is that there is no dubiety in the result; if both testicles are removed, then the sheep is surely castrated. It is also simple and rapid and can be successfully performed by any shepherd. With the bloodless castrator there is always a danger of "rigs"—that is, incompletely castrated sheep. The method is also more difficult and requires more patience and skill. At the same time it has been claimed that the degenerating testicle stimulates growth, resulting in a better grown lamb at sale time. In order to settle this question the following experiment was carried out in the summer of 1932:—

Ten pairs of twin half-bred male lambs were taken from a flock of Cheviot ewes. One twin was castrated with the castrator, the other with the knife. The live weight gain between castration and weaning was recorded for each lamb, and the gain made by one lamb castrated with the castrator compared with that of its brother castrated with the knife. The results are shown in the table below:

	Castrator	Knife
Live weight increase—		
1st pair	59 lb.	51 lb.
2nd ,,	57·5 ,,	51 ,,
3rd ,,	59 ,,	49·5 ,,
4th ,,	53·5 ,,	50·5 ,,
5th ,,	54·5 ,,	53 ,,
6th ,,	72 ,,	63 ,,
7th ,,	62 ,,	60·5 ,,
8th ,,	58·5 ,,	46 ,,
9th ,,	57·5 ,,	53 ,,
10th ,,	55 ,,	53·5 ,,

In every case the bloodlessly castrated lamb made more rapid gains, the average increase being 59 lb. as against an average of 53 lb. for those cut with the knife, an advantage of 6 lb. per head.

Seven single lambs castrated with the castrator averaged 64 lb. increase between castration and weaning, compared with an average of 58 lb. for seven cut with the knife, again an advantage of 6 lb. per head.

In addition to yielding a heavier lamb, the bloodless castrator gave a bigger lamb with bolder head and stronger bone, and in better condition.

The results of this small experiment show that the bloodless castrator gives better results than the knife if rigs can be avoided. Its correct use is a matter of patience and acquired skill. It is better to castrate when the lambs have reached a fair size and the testicles are fully descended. It is also advisable to have three men on the job, one to hold the lamb, one to pull down the testicle and steady the cord, and a third to work the instrument.

Notes from Agricultural Colleges

Craibstone

Potatoes, 1932.—The weather was suitable and the soil sufficiently dry for planting potatoes at the beginning of March, but the soil temperature was only about 36° F. The first planting of Arran Banner and Golden Wonder in the "Time of Planting" trial was made on the 1st of the month, subsequent plantings being made at the beginning and middle of each month up to June. Half of the tubers at each planting were well sprouted, the other half being unsprouted. The weather became colder about the middle of March and continued so well into April, and the soil temperature was rarely above 40° F. until the beginning of May.

The appearance and size of the shaws during the season were very interesting. As one would expect, the sprouted tubers came through the ground first, and those sprouted and planted in the middle of May were through the ground before those that were unsprouted and planted on 1st March. After they started growth, however, the unsprouted in every case grew taller than the sprouted planted on the same day, and the late planted ones were taller than those planted early.

The shaws of each were measured on the 31st August, and the following are the heights from the top of the drills :—

Height of Shaws

Planted	Sprouted		Unsprouted		Planted	Sprouted		Unsprouted	
	ft.	in.	ft.	in.		ft.	in.	ft.	in.
March 1st	2	0	2	6	May 1st	3	8	4	2
„ 16th	2	0	2	6	„ 16th	3	7	4	0
April 1st	2	6	3	0	June 1st	3	5	4	0
„ 16th	3	0	3	8	„ 16th	3	0	3	10

A point of considerable practical importance was that the shaws of all the sprouted tubers except the last planted were strong and sturdy, as were also the unsprouted of the first three plantings. Those that were unsprouted and planted on the 16th April were slightly down, while all the later unsprouted ones were badly broken down.

As one would expect, the early planted tubers were ripe first and there was also a considerable difference between the sprouted and unsprouted. When well-sprouted seed is planted reasonably early the crop is ready to lift much earlier. In August and September many who saw and expressed their admiration of the dark green healthy leaves of the late-planted unsprouted plants could hardly believe that the early planted sprouted plants which were ripening, and consequently much lighter in colour, were of the same stock.

A word of warning may be given to those who are making selections of healthy plants of different varieties of potatoes. It has been noticed that in many varieties some plants are slower than others in starting growth. These approximate to the late-planted, unsprouted plants, and the shaws are therefore darker green and considered more healthy. The crop from most of these was, however, generally less.

Similarly, when large quantities of nitrogen are applied, dark green, healthy-looking leaves are the result, but there is rarely a corresponding increase in tubers. Those who are making selections would be well advised not to use too much nitrogen.

The weights of crop obtained were as follows :—

Arran Banner

	Over 2″		2″-1¼″		Small	Diseased		Total	
Sprouted—	tons	cwt.	tons	cwt.	cwt.	tons	cwt.	tons	cwt.
March 1st . .	13	3	2	14	8	3	9	19	14
,, 16th . .	14	15	4	3	11	0	14	20	3
April 1st . .	14	4	4	3	8	0	14	19	9
,, 16th . .	16	9	4	6	11	0	16	22	2
May 1st . .	15	3	4	11	19	1	17	22	10
,, 16th . .	14	9	3	15	19	3	4	22	7
June 1st . .	12	6	4	0	11	1	12	18	9
,, 16th . .	11	12	4	9	11	1	12	18	4
Unsprouted—									
March 1st . .	11	15	3	4	5	3	4	18	8
,, 16th . .	10	16	2	17	8	3	9	17	10
April 1st . .	11	8	3	7	8	2	8	17	11
,, 16th . .	13	0	5	2	14	2	8	21	4
May 1st . .	11	6	4	9	14	3	8	19	17
,, 16th . .	9	3	5	2	19	3	15	18	19
June 1st . .	7	14	7	0	19	1	10	17	3
,, 16th . .	6	10	4	3	14	0	11	11	18

Golden Wonder

	Ware Over 1¾″		Seed 1¾″-1¼″		Small		Total	
Sprouted—	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
March 1st	6	1	3	12	0	16	10	9
,, 16th	4	14	4	5	0	19	9	18
April 1st	8	9	4	10	1	7	14	6
,, 16th	9	4	4	8	1	2	14	14
May 1st	10	3	3	4	0	11	13	18
,, 16th	9	4	4	2	0	19	14	5
June 1st	4	13	6	9	1	10	12	12
,, 16th	2	15	2	16	0	19	6	10
Unsprouted—								
March 1st	3	6	4	0	1	7	8	13
,, 16th	2	9	5	0	1	7	8	16
April 1st	3	9	5	12	1	5	10	5
,, 16th	3	17	6	1	1	13	11	11
May 1st	3	0	6	1	1	2	10	3
,, 16th	4	2	3	9	0	19	8	10
June 1st	2	16	3	9	1	15	8	0
,, 16th	1	18	3	16	0	12	6	6

It will be seen that this season, Arran Banner, planted on 16th April and in May, were best; while all the April and May plantings were about the same in the case of Golden Wonder, those planted earlier and later being less. The cold spell and the consequent low soil temperature apparently chilled the tubers and affected their vigour.

In every case, whether planted early or late, the sprouting was an advantage, the average increases per acre being :

	tons	cwt.
Arran Banner	2	16
Golden Wonder	3	0

These increases were mainly in ware.

Blight made its appearance in one or two spots in the middle of August but made little progress for a few days. A spell of comparatively sunless weather with frequent showers during the first half of September enabled it to spread slowly, so that the shaws of the earlies were mostly destroyed. Second earlies gradually followed, and the shaws of maincrops, except a few of the latest varieties, were affected somewhat earlier than they usually are, but it was some time before they were actually destroyed.

The following was the proportion (by weight) of affected tubers obtained from each variety :—

Early Varieties—	per cent.		per cent.
Ninetyfold	22	Arran Scout	8
May Queen	15	Main's Early Round; Katie Glover	7
America	14		
Duke of York	11	Arran Rose; Epicure	6

	per cent.		per cent.
Eclipse; Entente Cordiale; Immune Ashleaf; Witchhill	5	Arran Crest; Puritan	3
Arran Pilot; Catriona; Edzell Blue	4	Ballydoon; Sharp's Express; Dargil Early	2
		Di Vernon	1
		Early Pink Champion	0
Second Early—			
Abundance	14	Golden Marvel	3
Baron	7	British Queen	2
Arran Comrade; Royal Kidney; Great Scot	6	Response; Herald	1
		Sefton Wonder	0
Maincrop—			
Incomer	24	King Edward; Early Market	3
Up-to-date	17	Doon Star; St Malo	2
Arran Chief	14	Arran Victory; Achievement; Arran Consul; King George; Field-Marshal; Ally; Golden Wonder; Langworthy; Kerr's Pink; Irish Queen; Rhoderic Dhu; Irish Chieftain; President	0
Northern Star	13		
Champion	8		
Ben Cruachan	6		
Majestic; Tinwald Perfection	5		
Allanah; Arran Banner	4		

In the case of the earlies there was generally less than in the last two seasons, especially amongst the latest earlies, and the varieties that were worst affected then were worst this year. Attention may again be directed to Di Vernon, which was almost free.

It will be again noted that the russet skin of Sefton Wonder and Field Marshal helped these varieties to resist much better than their corresponding varieties—Great Scot and Up-to-date—without russet skins.

A few years ago a number of tubers badly affected with ordinary scab were planted under different treatments, some dusted with sulphur, others planted on green grass spread in the bottom of the drill—treatments supposed to be helpful in preventing scab—and a few planted without any special treatment. The result was that a uniform crop of clean tubers was lifted from all the plots, treated and untreated.

During the last year or two some attention has been paid, especially in America, to the use of certain chemicals—chiefly mercuric compounds—for the prevention of scab. The seed tubers were steeped in a solution for a short period some time before planting.

Last year, on a plot which had been dressed with lime at the rate of 4 tons per acre several years ago, there was a considerable amount of scab. This was considered to be a good place to try the effect of the mercuric treatments on the seed. Accordingly, seed of Golden Wonder, Kerr's Pink and Duke of York was treated with Agrosan S.B., perchloride of mercury, calomel and yellow oxide of mercury, and planted in the same plot as last year. A duplicate trial was carried out in a field where the soil is somewhat peaty.

In the first trial there was only slight scab on a number of the tubers, and there was no difference between the treated and untreated, while in the second trial there was no scab at all.

In a previous note attention was drawn to the advisability of using large seed for planting in years when ware is selling at a much cheaper rate than seed size. This year a trial was made with different sizes of Golden Wonder and the following result was obtained.

	Over 2″		1¾″		1¼″		Small	Total		Seed used		Total crop	
	tons	cwt.	tons	cwt.	tons	cwt.	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
8 oz. .	5	5	5	8	5	2	16	16	11	4	0	12	11
4 ,, .	5	13	4	14	4	6	19	15	12	2	0	13	12
2 ,, .	4	17	4	11	3	4	16	13	8	1	0	12	8
1 ,, .	6	7	3	9	1	14	10	12	0	0	10	11	10
½ ,, .	5	13	1	14	1	12	6	9	5	0	5	9	0

As in former trials, the largest seed produced the largest crop, but when the amount of seed planted is taken into account there is not much difference in the nett crop produced by the 8 oz. and 2 oz. setts, the 4 oz. being greater. There was, however, a much larger quantity of seed size (1¼″ to 2″) from the largest setts. When ware is worth so much less than seed size tubers it is worth the consideration of those who grow more particularly for the seed trade whether they should plant larger seed than usual.

In the case of those who grow more particularly for ware, the largest proportion is got where seed of the smaller size is planted, and when this is comparatively dearer the advisability of cutting and planting ware is worth consideration. In former trials it was demonstrated that, when properly done, cut setts produce about the same crop with the same proportion of ware as whole seed of the same size. Majestic is a variety that is often very blanky when cut setts are planted, and it was used for a trial with different methods of dealing with cut seed.

The methods and crop obtained were as follows :—

	Over 1¾″		1¾″-1¼″		Small	Total	
	tons	cwt.	tons	cwt.	cwt.	tons	cwt.
1. Cut beforehand and kept in dull place in boxes . .	13	5	2	0	14	15	19
2. Cut beforehand and kept in sunny place in boxes . .	7	14	1	7	8	9	9
3. Cut beforehand, limed and kept in sunny place in boxes .	13	11	2	6	15	16	12
4. Cut and put into bag . .	10	2	1	17	5	12	4
5, Cut and planted . . .	14	15	1	17	8	17	0
6. Cut, limed and planted . .	14	9	2	9	8	17	6
7. Whole seed	14	4	2	3	10	16	17

The tubers kept in a bright sunny place after cutting were very blanky and were much less vigorous than those kept in a dull place to allow the cut surface to heal slowly. Coating with lime to assist the healing process was distinctly advantageous. Cutting and planting at once was a distinct success, but it must be kept in mind that the soil was in a nice dry condition at the time of planting. In previous trials when this was not the case this method was not so successful, and the liming showed more effect.

Many people put their cut setts in bags, but this method is dangerous, because, if the bags stand for any length of time, the setts heat and the vigour is affected. The plants in this plot were not nearly so vigorous as the others.

The trial where Golden Wonder was grown under different conditions was again carried out. There was a very distinct difference in the health and vigour of the two plots and the following results were obtained :—

Good Conditions	*Poor Conditions*
Selected seed.	Ordinary seed.
Well sprouted.	Unsprouted.
Well manured.	Ordinary manuring.

Ware		Seed			Total		Ware		Seed				Total	
Over 1¾"		1¾"-1¼"		Small			Over 1¾"		1¾"-1¼"		Small			
tons	cwt.	tons	cwt.	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
10	10	4	11	16	15	17	2	6	2	17	2	0	7	3

This is in accordance with former trials and shows clearly why some crops of Golden Wonder are so poor.

It is generally believed that an application of lime has an adverse effect on the potato crop. An opportunity was afforded this year to test this belief, as part of a plot had got a heavy dressing (at the rate of 4 tons per acre) of lime several years ago, a part alongside being unlimed The shaws on the latter part were distinctly more vigorous than on the limed plot, and the crop was correspondingly heavier, as the following figures show. There was no scab on any of the tubers.

	Ware		Seed				Total	
	Over 1¾"		1¾"-1¼"		Small			
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Without lime .	10	3	4	9	0	19	15	13
With lime . .	7	8	4	10	1	2	13	0

Auchincruive

Pig-Feeding Experiment.—The experiment under review was planned to determine the relative values of whole milk, separated milk and whey in the feeding of pigs for bacon production, rations including a definite allowance of each being compared with a control containing no milk or whey. From four litters of pure-bred Large Whites, comprising 38 pigs, 32 were selected, 8 being from each litter. These were arranged in 4 groups of eight, made up by selecting two pigs from each litter; the groups were also alike as regards initial live-weight, sex and apparent uniformity.

The average age of the pigs at the commencement of the trial was 59 days, and the average live-weight almost 34 lb.

The meal mixture fed to all groups was as follows :—

	PERIOD 1 (42 days) Parts by weight	PERIOD 2 (42 days) Parts by weight	PERIOD 3 (47 days) Parts by weight
Thirds . . .	4	3	2
Barley Meal . .	3	3	4
Maize Meal . .	2	3	3
White Fish Meal .	1	1	1

The daily allowance of mixed meal fed to each group of pigs at the commencement of the experiment was as follows :—

Group 1.—Meal, 10 lb. (1¼lb. per pig per day).
Water, 4 gallons (½ gallon per pig per day).
Group 2.—Meal, 7·6 lb. (·95 lb. per pig per day).
Whey, 4 gallons (½ gallon per pig per day).
Group 3.—Meal, 6·4 lb. (·8 lb. per pig per day).
Separated Milk, 4 gallons (½ gallon per pig per day).
Group 4.—Meal, 5 lb. (·625 lb. per pig per day).
Whole Milk, 4 gallons (½ gallon per pig per day).

For groups 2, 3 and 4 the meal allowance was reduced by the amount of dry matter contained respectively in the whey, the separated milk and the whole milk fed to these groups.

In order to keep pace with live-weight increase, the rations were thereafter increased for all groups at the rate of 2 lb. per week (¼ lb. per pig per week), and water was added at the rate of 4 lb. to 1 lb. of dry meal. The daily allowance of meal per pig thus increased from 1¼ lb. at the commencement of the trial to 5¾ lb. in the final week of the experiment.

Each group of eight pigs was kept in one pen, and the housing for all groups was perfectly uniform.

The meals were fed raw and dry, and the allowance of milk, whey or water added immediately afterwards. All of the pigs were fed three times daily, at 6.30 a.m., 11.30 a.m., and 5.30 p.m.

Liberal amounts of oat straw were used as bedding throughout the entire period of the experiment.

The pigs were weighed at fortnightly intervals and again on the 131st day of the trial, when the experiment terminated. On the conclusion of the experiment two pigs from each group were retained for stock, and the remaining six pigs slaughtered.

The live-weights of each group at the beginning of the experiment, at the end of periods 1, 2 and 3, and the percentage carcass weights for the pigs slaughtered were as follows :—

	Live-weight in lb. at				
	Beginning of Experiment 27th July 1932	End of Period 1 8th Sept. 1932	End of Period 2 20th Oct. 1932	End of Period 3 6th Dec. 1932	% Carcass Weight
Group 1 (Control) .	269	601	1077	1678	78·8
Group 2 (Whey) .	269	617	1101	1698	78·0
Group 3 (Separated Milk) . . .	270	639	1123	1700	78·9
Group 4 (Whole Milk) . . .	269	639	1125	1730	78·8

It will be seen from the live-weight increases set out above that the supplements of half a gallon of whole and of separated milk proved decidedly beneficial up to the end of Period 1, but that there was little benefit as measured by live-weight increase later in the experiment. The group receiving whole milk, however, maintained throughout the entire period rather better bloom than the pigs in any of the other groups.

The carcass results are exceedingly good for all the groups, but do not show any significant difference in percentage of carcass weight to live-weight. Group 1 provided fully the leanest carcasses, group 2 being next in order in that respect. There was, however, a marked difference in the colour of the fat, and in groups 3 and 4 this was decidedly whiter and superior to that of either groups 1 or 2. The difference was so pronounced that the colour of the fat alone was sufficient to differentiate the milk groups from the water and whey groups.

The relative returns from the different rations are readily arrived at by considering the amounts of meal and milk or whey consumed by each group, and the live-weight increases obtained.

The figures for each group of eight pigs as are follows :—

Group 1.

Net live-weight increase		1409 lb.
Total amount of meal consumed .	3632 lb.	
Meal required for 1 lb. live-weight increase	2·57 lb.	

Group 2.

Net live-weight increase		1429 lb.
Total amount of meal consumed .	3318 lb.	
Total amount of whey consumed .	5240 lb.	
Meal and whey required for 1 lb. live-weight increase—		
Meal	2·32 lb.	
Whey	3·66 lb.	

Group 3.

Net live-weight increase		1430 lb.
Total amount of meal consumed	3161 lb.	
Total amount of separated milk consumed	5240 lb.	
Meal and separated milk required for 1 lb. live-weight increase—		
Meal	2·21 lb.	
Separated milk	3·66 lb.	

Group 4.

Net live-weight increase		1461 lb.
Total amount of meal consumed	2977 lb.	
Total amount of whole milk consumed	5240 lb.	
Meal and whole milk required for 1 lb. live-weight increase—		
Meal	2·04 lb.	
Whole milk	3·58 lb.	

When allowance is made for the saving in meal effected by the feeding of whey, separated milk and whole milk, and for the increase in live-weight over that of the control group, the return from the inclusion of these products is as follows :—Whey, ·64d. per gallon ; separated milk, ·86d. per gallon ; whole milk, 1¼d. per gallon.

These figures are arrived at on the basis of £7 per ton for the meal mixture, and a value of 5½d. per lb. live-weight—the equivalent of the dead weight price of 58s., at which the pigs were sold, and a carcass weight of 78 per cent.

The whole milk and separated milk, while particularly useful in the earlier stages of growth, have given a very poor monetary return for the entire fattening period ; for whey, on the other hand, there is a very satisfactory monetary return, and the control ration of dry meals supplemented with water actually gives each lb. live-weight increase at a food consumpt of 2·57 lb. and a food cost of just under two pence—a highly satisfactory result.

Cooking tests are being carried out with representative samples of bacon from the four groups, and the results of these will be available at a later date.

Reviews

Physiology of Farm Animals. F. H. Marshall and E. T. Halnan Cambridge University Press, 15s. net.

This work was intended to appear in two parts, the first on the general principles of Physiology as applied to farm animals, and the second on Nutrition. Of these the first part by Dr Marshall was published in 1920 and is now out of print. The second part, which was to have been undertaken by Professor T. B. Wood, was not completed before his death.

The plan of the work has now been altered. The part dealing with nutrition has been entirely rewritten by Mr Halnan and is incorporated along with the other part in one volume.

The text-book is addressed primarily to agricultural and veterinary students, but to anyone connected with the management of farm live stock it will prove a most interesting and instructive book of study and reference. All the functions of the animal organs are clearly described: the digestive system, the blood and its circulation, respiration, excretion, the nervous system, internal secretion, reproduction, are all amply dealt with, and the chapters on nutrition and foods are thoroughly up to date. The illustrations are excellent.

Soils: their Origin, Constitution and Classification. An Introduction to Pedology, by Professor G. W. Robinson, M.A., pp. 390, 1932. (Thos. Murby & Co., 20s. net.)

In his introductory chapter Professor Robinson points out that " the study of the soil from its close connection with the important art of agriculture has occupied, until recently, an intermediate position between pure and applied science. Most of the earlier investigations on soils have been directed towards the solution of problems arising from practical agriculture, and this circumstance has introduced complications both in the statement of the subject and also in the methods of research employed. The investigator of the relationships between the growing plant and its environment is often in danger of failing to secure an adequate view either of the soil itself or of the subject of plant nutrition."

The author defines Pedology as the study of the soil from the standpoint and by the methods of pure science; the work under review has therefore nothing to do with agriculture except incidentally, but none the less may be a valuable guide to the advanced student in agricultural chemistry, to the geologist, the plant ecologist, and, to a more limited extent, to the geographer.

After an introductory chapter dealing with the general aims of Pedology, the first section of the book deals with the origin, constitution and properties of soils. The general constitution of the soil is dealt with in Chapter II, the methods of soil formation in Chapter III, and in succeeding chapters the " clay complex," base exchange and soil organic matter are discussed in detail; two chapters follow on the general physical properties of soils and the water relationships of soils.

The treatment in these chapters is excellent. Professor Robinson deals with the complicated mass of material in a clear and lucid manner, and his pleasant style makes these chapters eminently readable.

In the next section the chief soil-groups of the world are dealt with; this is followed by a discussion of the difficult problem of classification, and an account is given, " with due reserve " as the author cautiously puts it, of the geographical distribution of soils. This last section is almost necessarily the least satisfactory in the book, since the knowledge of the soils discussed is in many cases limited.

Succeeding chapters deal with the methods of soil surveys, soil analysis, and plant growth and agriculture. Methods of analysis are given in the appendix, and a useful bibliography is attached to each chapter. As would be expected from one who has made such notable contributions to the methods of soil analysis as Professor Robinson, the section dealing with this subject is exceedingly well done.

Professor Robinson is a scholar as well as an agricultural chemist, and it is a pleasure in these days of much slovenly writing to read a book not only scientifically accurate, but written with some distinction of style. As already indicated, this work will appeal only to a rather special circle of readers ; to these it can be most cordially recommended.

Go East for a Farm : A Study of Rural Migration. E. Lorrain Smith. Oxford-Clarendon Press, 2s. 6d.

This pamphlet gives the results of an investigation carried out by the author in the south-eastern counties of both England and Scotland into the extent and the causes of the migration of farmers from west and north-west to south and south-east, especially in periods of agricultural depression. A fuller account of the survey, embodying the statistical evidence, gained for Mr Lorrain Smith the research degree of B.Litt. in the University of Oxford, and also the Research Medal of the Royal Agricultural Society of England in 1931.

Most people have heard about the remarkable influx of Scottish farmers into Essex in the later years of last century, after the great agricultural depression of the eighties had set in. But the movement was not confined to Essex nor to Scotsmen, and Mr Smith gives a fascinating account of the migration which has continued to take place since those times from Cornwall, Devon, and Somerset, from Wales and the north and north-western counties of England, and from the south-western counties of Scotland to the south-eastern and Midland counties of England, together with a notice of the Scottish parallel of the western farmer coming east to the Lothians, Fife, Angus, and Berwickshire. One interesting fact brought out in the figures is that during the ten years, 1921 to 1930, the migration from Scotland to the south-east of England was greater than in any ten-year period between 1880 and 1920.

The main attractions leading to the movement appear to have been that the farms were cheaper than in the original habitat, that they had easier access to markets, and that they were bigger. The reasons for the comparative success of the immigrants in their new conditions were partly that they often introduced a system of farming which was new to the district, and which was more profitable to the circumstances of the times, or that they worked harder or worked to better purpose than the former occupants, or that they lived more sparingly and more thriftily, or that they utilised the services of their own families more freely, or that they were sometimes better farmers technically and commercially, or a combination of some or all of these.

The treatise is an excellent piece of work, logically set forth and admirably expressed.

The Journal of the Orkney Agricultural Discussion Society (Vol. VII).

The latest issue of this annual publication fully maintains the high standard set by its predecessors. It is refreshing to come across a record of activity such as this, which is a faithful account of the proceedings of the Society during one session. Many of the papers read have a literary flavour beyond what one expects to find in an Agricultural Discussion Society, and all of them deal with matters which are of real importance in farming economics. The contribution of Mr J. M. H. Robertson on " Reclamation of Hill Land," that on " Trade and Exchange " by Mr Mackie Greig, and that of W. M. Mitchell on " Some Horse Diseases " are exceptionally interesting ; while the debates on " Old and New Varieties of Oats," " Land Nationalisation," and the relative importance of women and men on the Orkney farm, all exhibit shrewd insight and dialectic capacity of no mean order. A comprehensive and lucid exposition of the " Agricultural Marketing Act " is contributed by Mr G. Henderson, S.A.O.S., and some sane useful observations on " Rural Housing " are made by Dr W. B. Bannerman. Other subjects appearing in the miscellany include " Milling," " Weights and Measures," "Weeds and their Eradication," "Roadmaking," " Turnip-Singling," " Stack-Building," " Poultry Management," and a causerie on general topics—largely political—by Mr A. Calder.

The publication is worthy of a circulation beyond its immediate clientele, the farmers of Orkney, and those who may wish to see it should send for a copy (post free, 1s. 3d.) to Mr C. M. Allan, B.Sc., Agricultural College Office, Kirkwall, Orkney, who has succeeded Mr H. H. Corner in the secretaryship of the Society, and who seems also to have fallen heir to his predecessor's enthusiasm and editorial capacity.

Manufacturing Milk : A Survey of Milk Marketing and Utilisation in West Cornwall. F. J. Prewett. Oxford-Clarendon Press, 2s. 6d.

A series of studies intended to discover the processes of marketing and utilisation of milk in all the typical dairying districts of

England has been undertaken by the Oxford Institute of Research in Agricultural Economics, and two reports, one on Wiltshire and Somerset and one on Derbyshire, have already been issued. The present survey deals with an intensive dairying district in which only a small proportion of the output is sold for liquid consumption, the area being far distant from consuming centres. The bulk of the milk is made into butter, either domestically on the individual farms or in creameries. A small proportion is sold as cream, notably in the soft fruit season.

The reporter notes an almost total lack of organisation in marketing, prices to a great extent being arrived at individually. While it is often assumed that only a liquid milk sale assures the dairy farmer of a profitable return, nevertheless in West Cornwall about 80 per cent. of the total production goes into butter manufacture, and on the assumption noted there should be an actual loss on this output. Whether on account of the climate or other local conditions the West Cornish dairy farmer appears to be able to live and thrive even when the butter he produces has to meet the competition of world prices.

A strong plea is made for organisation. Pure Cornish farmhouse butter of high quality is in greater demand than supply, and combination among the farmers should be able to exploit this demand. As in some other instances, however, the dairy farmers are temperamentally disinclined to combine ; they are strongly individualistic ; and many of them take a pride in the quality of their own product, and are unwilling to lose this satisfaction through any pooling arrangement.

The publication of this report ought to cause some searching of heart among the farmers whose business it describes.

A Simple System of Farm Book-keeping. Bulletin No. 58, Ministry of Agriculture and Fisheries, price 6d. net.

Farmers who want a reliable guide to a plain and useful method of keeping their accounts cannot do better than spend a sixpence on this little publication, for which Messrs Bridges & Upfold, of the Agricultural Economics Research Institute at Oxford, are responsible. From the drawing up of the opening statement, through the recording of day-to-day transactions to the closing of the accounts and the preparation of the final balance-sheet, the instructions are clear and simple and the illustrations well chosen.

A special section explains the modfications needed in the case of the owner-occupier.

Journal of Animal Ecology. Cambridge University Press.

The significance of recent field investigations into the important problems relating to the distribution, fluctuations in numbers, and migrations of animal populations has led to an insistent demand for the publication in more adequate and convenient form of the results of observations of this nature. This need has now been met by the decision of the British Ecological Society to publish twice yearly a *Journal of Animal Ecology*, under the editorship of Charles Elton, assisted by A. D. Middleton.

The first number, issued in May 1932, is an attractive volume in appearance as well as in matter. It contains many-sided contributions, from studies of the fluctuations of insect populations in wheat and of bird numbers on a Oxfordshire farm, to a rookery census, an analysis of the ranging habits of wood-ants, and an account of the biology of the fruit bats of Australia. There are many illustrations, and a useful reference list contains summaries of papers dealing with animal ecology. The Journal, which may be obtained on application to Dr H. Godwin, Secretary of the British Ecological Society, School of Botany, Cambridge, is supplied to members of the Society for their annual subscription of 25s., and to non-members for 30s. The Journal promises to be a notable addition to British zoological literature and will provide material of much interest and value to field workers and zoologists in general.

General Assembly of the International Institute of Agriculture

THE eleventh General Assembly of the International Institute of Agriculture was held in Rome from 17th to 22nd October 1932. The British delegation comprised Sir A. Daniel Hall, K.C.B., F.R.S., LL.D. (Head of the delegation), and Mr H. L. French, C.B., O.B.E., of the Ministry of Agriculture and Fisheries, Mr J. M. Ramsay, O.B.E., of the Department of Agriculture for Scotland, and Mr D. A. E. Harkness of the Ministry of Agriculture, Northern Ireland.

The Institute's finances occupied a large proportion of the Assembly's time, and several important resolutions were passed, which will have the effect of making the position clearer and of enabling the Institute to carry on its work within a more definite budgetary limitation than has hitherto existed. Steps were also taken with a view to obtaining payment of subscriptions from certain countries that are at present in arrear.

It was agreed that if the Institute's income should be augmented during the coming year, the completion of the World Census of Agriculture should be a first charge on the additional receipts, after a certain proportion has been put to reserve. On the present budget the prospect of the Census being completed is somewhat doubtful.

An important agreement made with the League of Nations regarding the respective spheres of action of the League and the Institute in relation to international agricultural questions was ratified by the Assembly.

There are many international bodies dealing with various aspects of agriculture, and Governments often find it difficult to decide whether their claims to international status are fully justified. This matter was discussed on the initiative of the British delegation, and a scheme was adopted under which the various States will be asked to consult the Institute before according official recognition to these bodies or to conferences organised by them. The Institute will also endeavour to " rationalise " the activities of such bodies and the holding of international conferences.

Other questions were discussed relating to agricultural credit, agricultural education, and the comparative study of the agricultural laws and regulations in force in various countries.

Several matters relating to the Institute's staff were brought forward. The Court of Cassation of Rome having ruled that the Institute and its staff are not amenable to Italian Law in the matter of contracts of service, a resolution was passed setting up a special tribunal for the decision of questions relating to the status and remuneration of members of the staff. Note was also taken of the fact that in October 1931 the salaries of the staff were reduced by a resolution of the Permanent Committee. This step was at the time inevitable, and the position will no doubt be reviewed when conditions are more favourable.

Agriculture in the East of England

THE following note of a report on Agriculture in the East of England appeared in *Nature*, No. 3283, vol. 130.

The report on an "Economic Survey of Agriculture in the Eastern Counties of England," issued by the Department of Agriculture, University of Cambridge, and published by Messrs Heffer and Sons, Cambridge, price 2s. 9d. post paid, presents an analysis of the financial results for 1931 of nearly a thousand farms in the province. During the year farmers in this area experienced heavy losses. The general price level of agricultural produce averaged 18 per cent. below that necessary to provide occupiers with a reasonable return for their own labour and capital investment. The majority of those farmers who were fortunate enough to secure a profit enjoyed special marketing facilities, retailed milk, or concentrated on the production of livestock and livestock products, or both. As the eastern counties are generally described as a grain-growing area, it is rather surprising to find that while sales of cereals amounted to less than 14 per cent. of the gross income, sales of livestock and their products represented nearly 70 per cent. The very low prices obtainable for the 1931 cereal crops influence these proportions, but even taking this into consideration, cereals can be described as an important cash product on the larger farms only. The success of the small farmer, and these form the majority, is more dependent on the price of livestock and feeding stuffs than on those of cereals. Interesting comparisons are made of the organisation of the agriculture of the principal farming localities of the province: for example, central Norfolk light loams, the Norfolk "breck," central Suffolk heavy soils, south Essex London clays, south Cambridgeshire gravels, etc. The most depressed areas are the boulder clays of Essex and Suffolk, and the clays in west Cambridgeshire and Huntingdonshire. The report deals further with main factors influencing profits and with many other subjects of interest to administrators and to farmers.

Labour on Scottish Farms

The Agricultural Returns collected on 4th June 1932 give the following numbers of workers employed on that date on holdings exceeding one acre in extent. The occupiers of holdings, their wives and domestic servants are excluded, but members of the occupiers' families other than their wives are included.

	Regular Workers	Casual Workers
Males, 21 years and over . .	58,877	5,393
Males under 21 years . .	19,901	2,737
Total of males . .	78,778	8,130
Women and girls . . .	18,051	6,298
Total . . .	96,829	14,428
Grand Total . .	111,257	

The grand total is 1209 below that recorded in 1931, regular workers being fewer by 601 and casual workers by 608. Of the regular workers, men over 21 have decreased by 349 or 0·6 per cent., and males under 21 by 243 or 1·2 per cent. Women and girls regularly employed have decreased by 9, male casual workers by 73, and female casual workers by 535.

The decrease in the number of regular workers since 1922 amounts to 5507 or 5·4 per cent. Men over 21 are more numerous by 276, while the numbers of those under 21 have diminished by 3022, and female workers by 2761.

The number of casual workers of each sex is the smallest recorded since regular returns were first made in 1921. Annual variations in the numbers of these workers are of less importance than changes in the numbers of regular workers. Perhaps, however, there is some significance in the fact that the average total number for the years 1922-27 was 19,900, while the average for the years 1928-32 is 15,900.

Acreage under each Variety of Potatoes in 1932

A STATEMENT is printed on page 87, showing the averages under certain varieties of potatoes in Scotland in 1932, as returned by growers of one acre or over. These returns cover 131,662 acres out of the total acreage of 148,539, the difference as in previous years being principally accounted for by the total exclusion of certain districts in the highlands and western islands, and by the exclusion of holdings on which less than one acre is grown. The total acreage shows an increase of 20,437 acres as compared with 1931, and the acreage included in the returns of varieties shows an increase of 20,413 acres.

The area under First Earlies, 14,673 acres, is more by 2141 acres or 17·1 per cent. than that returned in 1931. Epicure, with 8683 acres or 1465 more than last year, accounts for 59¼ per cent. of the total against 57½ per cent. of the total last year. Sharpe's Express again takes second place with 1931 acres, showing an increase of 326 acres or 20¼ per cent. Eclipse, which was fourth in 1930 and 1931, has advanced to third place this year with 1531 acres, an increase of 276 acres or 22 per cent. Duke of York has fallen from third to fourth place this year with 1484 acres, a decrease of 55 acres or 3·6 per cent. These four varieties cover 93 per cent. of the whole area under First Earlies.

Second Earlies, with a total acreage of 15,104 acres, exceed last year's total by 1781 acres. Great Scot, with an increase of 1232 acres, covers 9048 acres or 60 per cent. of the total area under Second Earlies as against 58½ per cent. last year. British Queen, with 3800 acres, shows an increase of 19 acres and accounts for a further 25 per cent. of the total area. Royal Kidney again comes third with 491 acres, an increase of 121 acres over last year. Arran Comrade with 294 acres and Ally with 390 acres show increases of 14 acres and 140 acres respectively. These five varieties account for 92¾ per ecnt. of the total area under Second Earlies.

The area under Maincrops, 101,885 acres, shows an increase of 16,491 acres. Kerr's Pink, with 62,103 acres, an increase of 16,337 acres or 35¾ per cent., again maintains the first place and covers 61 per cent. of the whole area. King Edward VII is again second with 12,261 acres, a decrease of 2726 acres. Golden Wonder, Majestic and Arran Chief follow in the same order as last year with 9369 acres, 8494 and 2212 acres respectively. Majestic shows an increase of 1762 acres, but Golden Wonder has decreased by 5 and Arran Chief by 84 acres. These five varieties again account for 92¾ per cent. of the Maincrop acreage. The Up-to-Date group, which showed a decrease last year, records an area of 1087 acres, the same figure as in 1931. Dunbar Cavalier, with 710 acres, shows an increase of 587 acres, and the new varieties of Arran Banner and Arran Consul show increases of 405 acres and 219 acres respectively. The other varieties do not show any significant change.

Varieties immune from wart disease cover in all 96,252 acres or 73 per cent. of the total area included in the return; non-immune varieties cover 34,619 acres or 26¼ per cent., while the varieties not specified in the return account for 791 acres or less than 1 per cent. The percentage of immune varieties is greater than last year by 5¼, and that of non-immune is less by the same amount. Thus the advance of immune varieties continues, this year's percentage of 73 being the highest recorded since the returns were first taken in 1918.

Agricultural Returns, 1932

THE abstract of the Agricultural Returns printed on pp. 131-135 shows that the total area under all crops and grass amounts to 4,622,217 acres, a net decrease of 9983 acres as compared with 1931, the arable land being less by 5767 acres and the permanent grass by 4216 acres. The area under rye-grass and other rotation grasses and clover has decreased by 22,915 acres, the increase in the area under other crops being thus 17,148 acres.

The total area under the cereal crops is 992,551 acres, being 14,734 more than in 1931. The acreage under wheat shows an increase of 2048 acres or 4·1 per cent. ; oats an increase of 32,687 acres or 3·9 per cent., while barley has decreased by 19,032 acres or 21·7 per cent.

Mixed grain, rye and beans show decreases of 431 acres or 21·1 per cent., 538 acres or 17 per cent., and 574 acres or 17·3 per cent. respectively. The area under potatoes is larger by 20,437 acres or 16 per cent., but that under turnips and swedes is less by 12,864 acres or 3·6 per cent. The acreage under sugar beet has fallen from 955 acres to 665 acres, a decrease of 30·4 per cent. Cabbage shows an increase of 325 acres or 7·2 per cent., while rape shows a decrease of 3,008 acres or 28 per cent. The area under flax has fallen from 64 acres to 13 acres, a decrease of 79·7 per cent., and is again approaching the low acreages of 1929 and 1928 which were 3 acres and 1 acre respectively. Vetches, tares, etc. for fodder have decreased by 1274 acres or 12·3 per cent.

Rye-grass and other rotation grasses and clover show a decrease of 22,915 acres or 1·5 per cent., the area for hay being less by 25,141 acres or 6 per cent., and that for pasture being greater by 2226 acres or 0·2 per cent. The area under permanent grass shows a net decrease of 4216 acres or 0·3 per cent.; the area for hay increased by 811 acres or 0·5 per cent., while that for pasture decreased by 5027 acres or 0·4 per cent.

The area under wheat, barley, oats and potatoes, 1,136,853 acres, is 36,140 acres greater than last year.

The returns of live stock show that horses continue to decrease in number and that cattle, sheep and pigs have increased. Horses used for agricultural purposes are less numerous by 1525, while unbroken horses have increased by 186. "Other horses" have decreased by 1232. The total decreases in all classes is thus 2571 or 1·7 per cent. All classes of dairy cattle show increases. Cows in milk are greater by 5054 or 1·5 per cent., cows in calf by 1756 or 3·4 per cent. and heifers in calf by 4556 or 8·1 per cent. Bulls show an increase of 148 or 0·8 per cent. Other cattle, two years old and above, are less by 3897 or 2 per cent., but those one year and under two and those under one year show increases of 6869 or 2·3 per cent. and 9930 or 4 per cent. respectively. The total number of cattle has thus increased by 24,416 or 2 per cent. The total number of sheep, 7,916,424, which shows an increase of 85,637 or 1·1 per cent., is the highest recorded since statistics were first collated in 1866. Breeding ewes have increased by 27,623 or 0·8 per cent. and lambs by 75,638 or 2·3 per cent., while other sheep, one year and above, have decreased by 19,274 or 2 per cent. The number of rams, 96,133, is greater than in 1931 by 1650 or 1·7 per cent. Pigs show an increase of 3122 or 1·9 per cent. Sows are less by 653 or 3·2 per cent., but other pigs are greater by 3727 or 2·7 per cent., and boars by 48 or 2·2 per cent.

The acreage under rough grazings, 10,368,178, is greater than last year by 870,915 acres or 9·2 per cent. This increase is mainly due to the inclusion for the first time of an estimated area of over 700,000 acres of land in deer forests capable of being used for grazing although not actually being grazed at 4th June. In 1931 the acreage of rough grazings included in respect of deer forests amounted to 320,548 acres, and only included land actually being grazed at 4th June 1931. The total area of land in deer forests used or capable of being used for grazing in 1932 was 1,028,666 acres. The total figures for cattle and sheep in Scotland include 2613 cattle and 77,933 sheep grazing in deer forests on 4th June; of these 1292 cattle and 42,945 sheep were also included in returns made by agricultural occupiers. The remaining 1321 cattle and 34,988 sheep were not included in any Agricultural Returns, and represent the stock included in the special returns rendered by the proprietors of deer forests.

The Agricultural Returns include statistics of acreage owned by occupiers of holdings and particulars relating to poultry, but these particulars are not included in the printed abstract.

The total area of land under crops and grass returned as owned by occupiers of holdings in 1932 amounts to 1,482,088 acres, as compared with 1,460,446 acres in 1931, an increase of 21,642 acres. This area is 32·1 per cent. of the whole area of land under crops and grass; in 1931 the proportion was 31·5 per cent.

The poultry figures are as follows :—

Fowls over six months old . . .	3,486,138
Fowls under six months old . .	3,951,957
Ducks over six months old . . .	161,778
Ducks under six months old . .	82,225
Geese over six months old . . .	6,894
Geese under six months old . .	16,160
Turkeys over six months old . .	14,201
Turkeys under six months old . .	72,021

The returns of labour employed on farms are summarised at page 102.

Agricultural Conditions

Wintry conditions changed suddenly to very mild weather almost at the moment when the new year began and, except for a few night frosts in eastern districts at the beginning of March, the weather during the first three months of the year continued unusually mild and open for the season. In some western areas gales and rain were general throughout January, but elsewhere the rainfall was exceptionally light until the last week or ten days of March, when broken and stormy conditions prevailed in all districts. The cultivation of arable land and other farming operations made exceptionally good progress during this period of dry and mild weather, and in many instances cultivation was carried out under almost ideal conditions. Unsettled weather, accompanied by low temperatures and cold winds, was general throughout April and the first three weeks of May. The rainfall was not at all heavy, but the broken conditions rather seriously interfered with outdoor work, and the sowing of turnips was protracted. Remarkably mild, dry and sunny conditions prevailed throughout the whole country during June, and continued in the north and east during the early part of July. The genial weather had an excellent effect upon all classes of livestock, but the prolonged absence of moisture somewhat retarded the development of root crops, and for a time rain was urgently needed, especially in the western counties. Local showers were general during the second half of July. In August, however, warm, bright, dry weather was enjoyed in practically all parts of the country. A few thunder showers that occurred about the middle of August caused patches of the oat crop to be lodged, but the damage done was slight and, speaking generally, the grain harvest proceeded under exceptionally favourable conditions. In the Edinburgh area it was the driest August since at least 1785. The weather gradually deteriorated during September and October, and during the last three weeks of the latter month rain was general and at times persistent in all districts, especially in the north and west. During this period potato-lifting and the completion of the grain harvest were considerably delayed, while thatching and threshing were practically impossible; night frosts occurred occasionally in the north, but otherwise the weather during October was mild and advantageous for the growth of root crops. During the last week or ten days of November stormy conditions and heavy rain prevailed almost everywhere and put a stop to all kinds of outdoor work.

Most of the winter sowing of wheat was completed in good season and under favourable climatic conditions. Growth was promptly stimulated by open weather, and at the end of January the braird was exceptionally well forward for the date, while the plants had an unusually robust appearance. Small spring sowings were carried out during March. A large part of the seed was treated with "Ceresan," but on many farms the seed was sown rather too freely with the result that in some fields the plants were too thick on the ground. Cold, harsh weather during April temporarily brought growth to a standstill and some of the braird was discoloured by frost, but the plants responded to the higher temperatures that were general throughout May and June, and thereafter the crop made steady progress. At the beginning of July the crop was in ear, while at the end of that month the plants were reported to be both robust and healthy and the ears were filling satisfactorily; small portions of the crop had been lodged, but in most fields it was standing well. The only complaint of disease was to the effect that on a few farms in the Lothians the plants had been attacked by rust. The grain ripened satisfactorily, and during the last week or ten days of August harvest became general. The work progressed rapidly and most of the crop was cut and stacked in excellent order. The grain is well matured and of good colour; the general yield per acre, 23 cwt., is 2 cwt. above the ten years' average.

The weather broke during the last ten days of March just as farmers were about to begin the sowing of barley, and the work had to be postponed for at least a fortnight. Subsequently, however, sowing was generally carried out under good average circumstances and was completed before the end of May. The crop brairded fairly well, but throughout the early summer months it never had such a promising appearance as wheat. For a time, at the end of June, some of the plants lost colour and suffered from the lack of rain, but the wet unsettled weather during July had a most pronounced and beneficial effect upon the general appearance of the crop, and the grain ripened satisfactorily. In most of the eastern counties rather a large part of the crop was lodged. The work of ingathering began during the third week of August and was almost entirely completed before the end of September, although in the late parishes of a few districts it was the middle of October before the last stooks were removed. Where the crop was stacked before the end of September it was secured in very good order but the remainder suffered damage from the weather, with resulting discoloration of the grain. A larger proportion of the grain than usual is of malting quality. The average yield per acre, 19·3 cwt., is 1·5 cwt. above the decennial average.

In consequence of the lack of frost during the winter the land required more harrowing than usual, but, despite this fact, large stretches of land in eastern districts were sown with oats before the end of March; in western districts seeding began earlier than usual but the work did not make very much headway until the beginning of May. Frosty nights, however, retarded germination, and a lack of moisture during June caused the plants to become rather stunted, particularly on light soils. Minor attacks of grub and wireworm were reported, but the damage caused by these pests was insignificant, and at the end of July the crop generally had a healthy and robust appearance, and the prospects were good. The heads of grain filled out better than was expected and the straw lengthened somewhat. In some fields the crop was lodged, but not to any considerable extent, and when harvest began during August the work at first made good progress. The greater part of the crop was secured before it had been weathered, and was stacked in unspoiled condition, but in the north and west harvest operations were rendered difficult by wet weather, and the long exposure which some of the crop suffered in those districts caused it to deteriorate very considerably. Where the crop was not badly lodged the grain is of good quality in every respect. The average yield, 17·2 cwt. per acre, is above the ten years' average by 2·1 cwt.

In some fields the bean plants appeared above the ground before the end of March. Growth was at first healthy and strong but was checked somewhat by the dry weather in June. The plants podded well, and at the end of August the crop was ripening satisfactorily, while on some farms harvest had begun. During the next few weeks, however, the broken weather and the lack of sunshine delayed harvest and rather spoilt the quality of some of the crop; at the end of October portions of the crop had not yet been secured. In the principal districts where beans are grown the yield exceeded the average by from 5 to 10 per cent.

The soil was in good condition for the planting of potatoes, which began at an early date. At first it seemed probable that the work would be accomplished more expeditiously than usual, but unfavourable weather caused delay, and the planting of maincrop varieties was not completed much before the end of May. First earlies did not grow very well, and in a few cases the harvest was rather disappointing, but the weather conditions during July suited second earlies and maincrop varieties admirably, and at the end of that month the haulms everywhere had a fresh and flourishing appearance and were unusually free from disease. During the last week of August the crop was touched by occasional night frosts, and slight traces of blight appeared among susceptible varieties, but the disease did not spread, and, when harvest began, a noticeable feature of the reports on the crop was the almost entire absence of blight in most parts of the country. During the first half of October the digging of potatoes was carried out under fairly satisfactory conditions, but, delayed by the broken weather that followed and the soft wet state of the fields, the lifting of the tubers was protracted, and some of them were pitted in rather a dirty condition. A few reports mentioned that the tubers were rather too large for market requirements and that some varieties yielded practically no potatoes of seed size. In nearly every district where the quality of the crop was not categorically stated to be " good " it was reported as " excellent." The yield per acre, 7·7 tons, has been exceeded only in 1929, when it was 8 tons.

The preparation of the land for root crops was hampered by rain, and sowing was late in being finished. Germination was slow, and at the beginning of July a small proportion of the turnip crop had not yet brairded, while in many districts, as a consequence of dry weather in June, the prospects of both turnips and swedes were then very uncertain. The mild, humid weather of July, however, favoured the plants and, where the crop was not sown too late, they made a rapid recovery. Swedes made rather better progress than turnips. A few complaints of finger-and-toe were received, and in the drier districts and on light soils the plants were slightly affected with mildew, but, speaking generally, the crop was sound and healthy. In some fields weeds made more headway than usual after cultivation had been discontinued. Until the month of September the roots did not bulb very satisfactorily, but the mild and open weather during the autumn was advantageous for growth, and in many districts where it was decidedly backward in the earlier months of the year the yield of the crops was equal to the average.

Mangolds grew slowly at first, but after the middle of July they made better progress than turnips and developed into a sound, healthy crop. In the Lothians "bolting" occurred in many fields, while in Berwick the crop was said to be disappointing. In South-East Perth and Dunbarton, on the other hand, the plants grew extraordinarily well, and the estimates of the yield made in these areas at the beginning of October were 10 per cent. above the normal. Indeed, judging by the reports then received, it appeared that the roots made most progress in some of those districts where usually they are grown only on a very small scale. The average yield, 20·4 tons per acre, is 2·2 tons greater than the ten years' average.

Sugar Beet was just coming through the ground at the end of May. The plants received very little moisture until September, but thereafter they made good average progress and bulbed satisfactorily. The roots were said to be of very good quality. A large part of the crop had been sent to the factory in a clean condition before the end of November.

"Seeds" and Meadow Hay.—The lodging of the grain crops last season caused comparatively little damage to ryegrass and clover seeds. The crop became well established during the mild winter months and showed exceptionally thick and strong growth, but cold weather in April checked the vitality of the young plants, and at the end of that month it was doubtful whether the crop was much better than the average for the time of the year. During the last week of June a few farmers in the southern and eastern counties took advantage of the dry weather to begin the harvesting of hay. For a few days cutting proceeded under almost ideal conditions, and in early districts a small part of the crop was secured in excellent order. Gradually, however, the weather became more and moer unsettled and the work more difficult until, at the end of July, harvest was practically at a standstill, in all stages of completion. Where cutting began very early the hay was secured in excellent condition, but that portion of the crop which was cut somewhat later was harvested in only fair order. Where the work was begun after the weather became unsettled some of the hay was so long lying in the fields or standing in coles that portions of it were considerably damaged by rain. Meadow hay bulked slightly better than "seeds" hay. Cover was generallly deficient in the crop.

Ploughing and the carting of manure were pushed forward whenever the weather and the soil conditions permitted, but at the end of November the work was rather backward owing to the wet state of the fields and in some cases to the lateness of the harvest. The sowing of winter wheat was retarded by wet weather, and some of the work was carried out when the conditions were not entirely favourable for seeding. Much of the land used recently for potatoes had been sown before the end of November, but on some of the ground intended for wheat the turnip and swede crop had not then been lifted. Increases in the acreage under wheat were reported from many districts.

The mildness of the weather during the first three months of the year kept pastures extraordinarily fresh and green for the season, and enabled farmers to economise in the consumption of roots. Grazing cattle throve remarkably well during the summer months, but in some western areas the drought during June had rather a serious effect on the grazings, and cattle were in consequence temporarily short of keep. The beasts came off the grass in satisfactory condition and when housed they made good average progress. Dairy cattle summered well. At the end of September artificial feeding was being largely used on many farms, and where hand feeding or extra green food was supplied the milk yield was well maintained. At the beginning of December dairy cows were reported to be in good average condition, but the few still out on grass were, of course, not milking very well. Sheep flocks came through the winter very satisfactorily, and, when lambing commenced, the ewes generally were in good condition. The crop of lambs was rather above the average in most districts. On low ground the results were somewhat better than on the hills. The lambs put on flesh very well, and several reports mentioned that they grew bigger than they did in recent years and were marketed in good bloom. Hill sheep especially benefited by the bright summer weather, and some of the Blackface lambs off the hills were sent to the butcher earlier than usual. The unsettled weather during the autumn was unfavourable for the flocks, and the prevalence of lameness indicated that foot rot was rather widespread among both lowland and hill stocks. At the beginning of November, however, ewes were said to be in good breeding condition, and the prospects for the winter were not at all unfavourable.

In some of the south-western districts the scarcity of experienced milkers, both male and female, continued throughout the year. Otherwise the supplies of regular workers amply satisfied the demands. Owing to the slow progress made with harvest the demand for casual labourers was rather greater than usual, and in some districts unemployed men from towns were engaged. In the south Irish labourers were employed for harvest as usual. At the Martinmas hiring-fairs many competent single and married men failed to secure engagements.

Annual Estimates of the Produce of Crops

The following Statement regarding the Produce of Crops for 1932 was issued on 15th December.

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots, in SCOTLAND in the Year 1932, with COMPARISONS for 1931, and the AVERAGE YIELD PER ACRE of the Ten Years 1922-31.

Crops		Estimated Total Produce		Acreage		Average Estimated Yield per Acre.			Average of the Ten Years 1922-1931
		1932	1931	**1932**	1931	**1932**		1931	
Wheat . .	*Tons* *Quarters*	60,000 270,000	48,000 223,000	52,072	50,024	*Cwt.* *Bushels*	23·0 41·5	19·2 35·6	21·0 38·6
Barley (including Bere)	*Tons* *Quarters*	66,000 342,000	74,000 388,000	68,868	87,900	*Cwt.* *Bushels*	19·3 39·7	16·8 35·3	17·8 37·1
Oats . . .	*Tons* *Quarters*	746,000 4,993,000	622,000 4,251,000	867,374	834,687	*Cwt.* *Bushels*	17·2 46·1	14·9 40·7	15·1 41·3
Beans . .	*Tons* *Quarters*	2,600 11,900	2,600 12,200	2,737	3,311	*Cwt.* *Bushels*	19·3 34·7	15·9 29·5	18·1 32·8
Hay from Rotation Grass .	*Tons*	659,000	728,000	397,116	422,257	*Cwt.*	33·2	34·4	32·8
Hay from Permanent Grass	*Tons*	154,000	154,000	120,534	117,433	*Cwt.*	25·6	26·2	26·7

Hay from Timothy Meadows	*Tons*	107,000	111,000	45,920	48,210	*Cwt.*	46·5	46·2	44·0
Potatoes . .	*Tons*	1,142,000	700,000	148,539	128,102	*Tons*	7·7	5·5	6·6
Turnips and Swedes . .	*Tons*	5,780,000	5,438,000	348,464	361,328	*Tons*	16·6	15·1	16·6
Mangolds . .	*Tons*	21,900	19,600	1,072	1,206	*Tons*	20·4	16·2	18·2

NOTE.—The total produce of wheat, 60,000 tons, is 12,000 tons greater than that of 1931. The area under the crop is greater by over 2000 acres, while the average yield per acre, 23·0 cwt., is 3·8 cwt. over last year's figure, and 2·0 cwt. above the ten years' average. Barley, with a total produce of 66,000 tons, shows a decrease of 8000 tons. This is the smallest output on record, and is not much larger than the output of wheat. The area harvested is less than that of 1931 by 19,032 acres, while the average yield per acre, 19·3 cwt., is 2·5 cwt. greater than in the preceding year, and 1·5 cwt. above the ten years' average. The total produce of oats, 746,000 tons, is greater than that of 1931 by 124,000 tons. The area shows an increase of 32,687 acres, while the average yield per acre, 17·2 cwt., is higher than that of the preceding year by 2·3 cwt., and above the ten years' average by 2·1 cwt. The total produce of beans amounts to 2600 tons or the same as in 1931. The average yield per acre, 19·3 cwt., is 3·4 cwt. more than in the preceding year, and 1·2 cwt. more than the ten years' average.

The total produce of hay of all kinds, 920,000 tons, is 73,000 tons below last year's total. Hay from rotation grass, with a total production of 659,000 tons, is 69,000 tons below the total of the preceding year. The area is smaller than in 1931 by 25,141 acres, while the yield per acre, 33·2 cwt., is 1·2 cwt. below that in 1931, but is 0·4 cwt. above the ten years' average. Timothy meadows, with an average yield of 46·5 cwt. produced 107,000 tons, or 4000 tons less than last year, while other meadows with an average yield of 25·6 cwt. produced 154,000 tons, the same as in 1931.

The outstanding feature of the returns is the large increase in the production of potatoes, the total being 1,142,000 tons as compared with 700,000 tons last year and 860,000 tons in 1930. The increase over 1931 is thus 442,000 tons or 63·1 per cent. The crop is only 13,000 tons short of the very large crop produced in 1929. There is an increase in the area of 20,437 acres, while the yield per acre has also increased from 5·5 tons to 7·7 tons, the ten years' average being 6·6 tons. This yield per acre has been exceeded only in 1929, when 8·0 tons were produced per acre; in 1920 and 1922 the yield was 7·6 tons. Turnips and swedes, with a total produce of 5,780,000 tons, show an increase of 342,000 tons. The area is less than in 1931 by 12,864 acres, but the yield per acre, 16·6 tons, is 1·5 tons above that of 1931, and is the same as the ten years' average.

The total produce of mangolds, 21,900 tons, is 2300 tons above that of last year; the average yield per acre, 20·4 tons, is 4·2 tons greater than in 1931 and 2·2 tons greater than the ten years' average.

All the above crops, except hay from rotation grass and from permanent grass, show increases in yield per acre as compared with 1931, and are also above the ten years' average, except turnips and swedes, the yield of which is equal to the average.

SCIENCE AND PRACTICE

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS

Studies on the Breaking Strength of Straw of Oat Varieties at Aberdeen, Idaho. *L. L. Davis and T. R. Stanton. Jour. Amer. Soc. Agron., Volume* 24, *No.* 4, 1932.—Experiments were made on the breaking strength of straw of the registered improved and standard varieties of oats grown in the cereal-improvement nursery at Aberdeen, Idaho. The straw-breaking tests were made on a machine described by Professor S. C. Salmon of the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, and built by the Engineering Department of the Kansas State Agricultural College. The straw-breaking is accomplished by gradually lowering the weight supported by a coil spring. Five straws were broken in the machine for each breaking trial.

Observations on resistance to lodging in the field agreed with the results of the straw-breaking tests for most of the varieties reported upon in this paper. The chief advantage of a satisfactory mechanical straw-breaking test for determining strength of oats was that it could be used where lodging of the grain did not occur. Another advantage was that it could be used to supplement observations on field lodging and to test hybrids where the quantity of material was limited. The data obtained from the straw-breaking tests on the registered improved varieties clearly separated the mid-season from the early varieties. Significant correlations were found to exist between the breaking strength of straw and several other characters, such as weight of panicles, weight of grain, weight of straws broken, height of culm and width of second leaf. In general, the reputed stiff-strawed varieties as determined by field observations, when subjected to a mechanical straw-strength test, showed the highest resistance to breaking.

Natural Crossing in Wheat, Oats and Barley at Saskatoon, Saskatchewan. *J. B. Harrington. Scientific Agriculture, Volume xii, No.* 8, *April* 1932. (Author's summary.)

"(1) A special natural crossing project in wheat, oats and barley was carried on for 5 years at Saskatoon, Saskatchewan.

"(2) The average amount of natural crossing in wheat was 0·88 per cent. with a range from 0·00 per cent. to 2·16 per cent. The average for hulled oats was 0·07 per cent. with a range from 0·00 per cent. to 0·20 per cent., and for the hull-less variety Liberty 3·68 per cent. with a range from 0·51 per cent. to 9·82 per cent. The average for awned barley was 0·07 per cent. with a range from 0·00 per cent. to 0·17 per cent., and for the hooded variety White Hull-less 0·16 per cent. with a range from 0·00 per cent. to 0·37 per cent.

"(3) While the differences between crops and species were large, seasonal effects did not appear to be very important. However, the results seemed to indicate for wheat and barley a greater propensity for natural crossing under humid conditions than under dry conditions."

New Zealand Pasture Seeds. *E. Bruce Levy, Agrostologist, Plant Research Station, Department of Agriculture, Palmerston North. New Zealand Journal of Agriculture, Volume* 44, *No.* 4, *April* 1932.—About 94 per cent. of the exportable products from New Zealand are derived from grass land. All-the-year grazing, supplemented by hay and silage derived from pasture, is the arresting feature of New Zealand farming.

Any serious attempt to improve the productive, lasting, or disease-resistant qualities of the more important pasture plants calls in the end stages for an organisation that will see to the production and perpetuation on a commercial basis of these proven types that are the outcome of natural selection or intensive breeding. Any breeding work in pasture plants, any effort to improve species production, type persistency, etc., is from the economic aspect doomed to failure without some system of seed certification.

Researches in New Zealand have shown that different strains of herbage plants have developed according to the farming system practised. The old permanent pastures hold, with certain exceptions, to the permanent strain. The short rotation areas have evolved a short-lived type; the arable and annual cropping areas have run distinctly to an annual type. Crops grown specifically for seed have evolved towards stemmy, high seed-yielding types. The cold-winter countries have produced scant herbage, stemmy, quick maturing, short-lived forms, and the mild-winter countries have produced winter-growing forms. The permanently grassed, high-production soil-types have produced high-production forms, and the low-production permanently grassed soils have produced low-production types.

British indigenous cocksfoot and British indigenous ryegrass were both finer in the leaf, more dense, but notably lower-producing under sward conditions than the New Zealand cocksfoot or New Zealand ryegrass, and there is a danger if these were sown under high-production conditions in New Zealand that they would be swamped by rank volunteer growth such as Yorkshire Fog, New Zealand white clover, or New Zealand ryegrass.

There are some extremely fine-leaved but low-production forms of cocksfoot within British indigenous cocksfoot associations, and the surmise is that these forms would make a closer sward on low-fertility soils than would the broad-leaved higher-producing types. Wild red clover from the Kent pastures represents a type inherent to low-fertility soils. Kentish wild red clover may do better on those low-fertility habitats than any other forms of red clover, but it would not be advocated to grow wild red clover where soil conditions were good enough to grow high-production forms of Montgomery red clover.

Certified New Zealand perennial ryegrass is a true perennial type localised in certain high-production areas, some of which have been under grazing for upwards of sixty years. The type is dense-crowned, multi-tillered, erect rather than prostrate, with foliage dark-green in colour, high-producing, moderately early-maturing, and capable of a good payable seed crop; rather less rapid in seedling growth than ordinary commercial false perennial types, but faster than British indigenous ryegrass. All the imported English, Irish and Scottish lines of commercial perennial ryegrass failed badly after two years' broadcast trial at the Plant Research Station. Lines from Germany, Sweden, Russia, Denmark, America and Australia, ranged from bad types to good types of false perennial.

SOILS

Superphosphate as a Manure for Fen Peat Soils of various Countries. *C. Krügel, C. Dreyspring and F. Heinrich. Superphosphate,* 1932, v. 169.—Experiments carried out at the Hamburg Research Station with superphosphate as a top dressing for various crops grown in Fen Peat soils show that on these naturally calcium-rich soils superphosphate is a most suitable manure, and with potash increases the quantity and quality of the crop to a marked degree. The amount of P_2O_5 absorbed by the crop is shown to be about 50 per cent. of the total P_2O_5 applied.

The Control of Wheat Gall-Fly by Soil Cultivation and Manuring. *H. Klee. Die Ernährung der Pflanze,* 1932, *28*, 323.—In wheat-growing areas in Holstein the larvæ of the wheat gall-fly (*Contarinia tritici Kirby* and *Sitodiplosis mosellana Gehin*) have in some cases caused a reduction of as much as 50 per cent. in yield. Thorough cultivation of the soil with a dressing of (1) 4 cwt. calcium cyanamide, (2) 16 cwt. quicklime, (3) 8 cwt. kainit per acre applied at different times brought about average reductions of 40 per cent., 47·5 per cent. and 59·1 per cent. in the number of flies emerging. Kainit applied immediately after ploughing in autumn decreased the number of flies by 80·3 per cent.

The Control of Gout-Fly (*Chlorops tæniopsis*). *H. Lokscher. Die Ernährung der Pflanze,* 1932, *28*, 357.—Wheat crops grown in Moravia, especially after barley, suffer badly from attacks of gout-fly. It is found that the ravages of the fly are checked where conditions favourable to normal plant growth exist. The addition of normal dressings of phosphatic and potassic fertilisers decreases the damage done by the fly, but the reverse is the case with nitrogenous fertilisers, which seem to soften the straw and make the plant less resistant.

The Effect of Potash Manuring on the Yield and Sugar Content of Sugar Beet. *O. Engels. Die Ernährung der Pflanze,* 1932, *28*, 381.—Sugar beet was grown in plots on a rich loam which had received 2½ cwt. sulphate of ammonia, 3½ cwt. superphosphate and varying amounts of 40 per cent. potash manure salts per acre. Application of 1¼, 2½, and 4 cwt. potash salts per acre produced increased yields of 40, 68 and 80 cwt. per acre respectively, while the sugar contents were increased by 0·42 per cent., 0·91 per cent. and 0·95 per cent. respectively.

Potato Scab and Manuring. *Eichinger. Fortschritte der Landwirtschaft Wien,* 1932, *7*, 193.—While the prevalence of potato scab is dependent to a large extent on weather conditions, soil reaction and variety of potato grown, it is shown that a suitable choice of artificial manures may bring about a material decrease in the number of infected tubers. Nitrate of soda, basic slag and muriate of potash all tend to increase scab, while sulphate of ammonia, superphosphate and sulphate of potash, or sulphate of potash magnesia dressings are accompanied by a marked decrease in infection.

Does Potash prevent Rust in Cereals? *Weise. Die Ernährung der Pflanze,* 1932, *28*, 362.—During field manurial tests on wheat, it was observed that while untreated and "nitrogen phosphate" plots were badly affected by rust, those receiving potash were quite free from infection. Similar findings are quoted from the current scientific literature. The action of potash is ascribed to a strengthening of the plant tissues.

The Control of Weeds in Cereal Crops on Moss Peat Soils. *F. Brüne and C. Husemann. Mitt. d. Vereins z. Förderg. d. Moorkultur i. Deutschen Reiche,* 1932, *50,* 32.—In moss peat soils weeds are prevalent in cereal crops, and on account of the peculiar nature of the soil cannot be eradicated by mechanical means as in mineral soils. Experiments were carried out in which dressings of 1½ to 6½ cwt. Hederich kainit per acre were applied to the cereal four to five weeks after sowing in the case of summer crops, and about the middle of November with winter crops. Successful control of weeds such as redshank (*Polygonum persicaria*), groundsel (*Senecio vulgaris*), hemp nettle (*Galeopsis tetrahit*), chickweed (*Stellaria media*), spurry (*Spergula arvensis*), cornflower (*Centaurea cyanus*) was obtained.

Grassing Experiments on Hill Country in Whangamomona County. *E. B. Levey. The New Zealand Journal of Agriculture,* 1932, *44,* 79.—Hill pastures were burned in late autumn and resown, after which pasture carrying 3 to 4 sheep per acre was obtained. When the yield decreased the burning and sowing were repeated. Dressings of various phosphatic manures were applied after burning, and it was found that 3 cwt. superphosphate per acre applied every third year proved most satisfactory.

The Effect of Neutral, Acid and Alkaline Manures of Different Physiological and Chemical Character on the Reaction of the Soil and the Yield. *O. Lemmermann, L. Fresenius and E. Gerdum. Zeitschrift für Pflanzenernährung, Düngung und Bodenkunde, Bd.* 26, *Heft* 5-6, 1932.—A comparison was made of the following treatments in a series of field plots: (1) A physiologically acid mixture—sulphate of ammonia and superphosphate, (2) a physiologically neutral mixture—urea and dicalcium phosphate, (3) a physiologically alkaline mixture—nitrate of soda and basic slag, and (4) alternating dressings of (1) and (3). Equivalent amounts of nitrogen, phosphate and potash respectively were added to all plots, and the effects of the various treatments were also compared on plots (*a*) with and without lime, (*b*) with and without "Phonolith," and (*c*) with and without acid peat. The results show that the sulphate of ammonia in treatment (1) rendered the soil distinctly more acid; treatment (2) scarcely altered the soil reaction; treatment (3) caused a decrease in the acidity of the soil, and in treatment (4) the acidifying effect of (1) was greatly reduced by (3). Superphosphate and potash had scarcely any effect on the soil reaction. Treatment (1) produced the best crop of potatoes, whilst the best crops of roots and of barley were obtained with treatment (3).

DAIRYING

Cause of Emery Taste in Milk. *Weich and Bauer. Fortschr. Landw. 7,* 7-9, 1932.—An "emery" taste in milk may be produced by traces of copper and zinc, dissolved from the utensils or equipment with which the milk has come in contact. A sample of milk exhibiting this characteristic taste contained 3·8 milligrams copper per litre, whereas normal milk contained only 0·37 milligrams.

Colour in Milk. *Rieche and Wilson. Milk Plant Monthly, 21* (8), 24-7.—The blue colour observed in some samples of milk may be due to physiological disturbances in the cow, or it may be associated with the food factor. The addition of water to the milk intensifies the blue colour. The temperature of pasteurisation appears to be an important factor in affecting the blue colour. Pasteurisation at 145° F. appears to keep the blue colour at a minimum.

Tallowiness in Milk. *Kende. Milchwirtschaft. Forsch., 13,* 11.—Tallowiness in milk is due to oxidative changes in the butter fat. Certain milks, however, contain substances (anti-oxidants) which resist these changes. Such substances are derived from the food supply, and green food is most effective in preventing such changes. On the other hand, metals and metallic salts accelerate tallowiness.

Defects in Butter associated with Water Supply. *Virtanen. International Dairy Congress,* 1931.—While some of the worst butter defects arise from the action of metals (*e.g.* oiliness and fishiness), or from the effects of specific enzymes (*e.g.* fermented, cooked and bitter flavours) yet a number of important faults are traceable to the action of specific bacteria. Bacteria which liquefy gelatin do the most damage to butter. Of these, two organisms, *B. fluorescens* and *B. punctatum,* commonly derived from the water supply, may cause considerable loss. They are controlled to some extent by ripening the cream to a full acidity and by an appropriate salting of the butter.

ANIMAL BREEDING

Cattle

Studies on the Inheritance of Colour and Pattern in Cattle. *R. Pfahler.* 1931. *Atschr. indukt. Abst., 58,* 177-221.—One thousand two hundred animals of the (red) Spotted Mountain Cattle of Wurttemberg formed the material for this investigation. There was found to be no correlation between the degree of spotting and the shade of the red colour nor was there any tendency towards greater pigmentation on one side of an animal than on the other. Neither did sex appear to have any effect either as regards the degree of spotting or the shade of red.

As regards spotting it was found that the pigment centres were distributed systematically on both sides. A positive correlation was obtained for the degree of spotting between cows and their offspring but not between sires and their progeny. Nevertheless the fact that the progeny of some bulls exhibited fraternal correlation while others did not was taken as demonstrating that true genetic segregation had taken place.

With regard to the shade of red, the results were not conclusive and could not be accounted for on a single factor basis when the shades were grouped into light, medium and dark. On the whole, the progeny of either lighter or darker bulls tended to revert to the medium shade. The coat of the new born calf during the period of six to eight weeks lightened slightly.

The Influence of Age of First Calving on Milk Secretion. *C. W. Turner.* 1932. *Miss. Res. Bull.* 164.—This is in many ways a confirmation of the work which M'Candlish did regarding the most economic age at which to calve Ayrshire heifers. It will be recalled that M'Candlish found this to be two years and six months. Dr Turner's study extends over four breeds, Ayrshires, Jerseys, Guernseys, and Holsteins. He points out that the increase in milk and fat production in heifers calving after thirty months of age in all these breeds is practically negligible. In other words, every heifer remaining unproductive at thirty months of age or over is being maintained at a loss, not only of the maintenance cost and of the investment of the animal, but in the productive life also. Yet his figures show that 43 per cent. of the Ayrshire cows calved after thirty months of age.

This study clearly revealed a significant increase in milk and fat production if calving was delayed till the animal reached thirty months of age. The results seem to confirm the theory that this increase in milk and fat poduction owing to the delay in the time of first calving is due to growth in body weight. Increase in yearly fat production is about 20 lb. per 100 lb. increase in body weight. The youngest heifer included was a Jersey which calved at thirteen months; the youngest Guernsey calved at sixteen months; while the youngest Ayrshire and Holstein Friesian calved at seventeen months. As to whether, under certain circumstances, it would be advantageous for heifers to calve down for their first time at under thirty months of age depends to a great extent upon environmental conditions. As it is, the difference in age at first calving between the four breeds shows very little variation. What stands out clearly is that nothing could be gained by delaying the calving of dairy heifers beyond thirty months.

The Functional Relation of Yearly Feed Cost and Butterfat Production in Dairy Cattle. *R. E. Hodgson.* 1932. *Jour. Dairy Science, Volume* 15, *No.* 3, *pp.* 212-219.—The yearly butterfat production of dairy cows is regulated and influenced by a number of hereditary and physical factors. The ability of an animal to produce a large amount of butterfat in a year is inherited, but unless the physical factors involved are adequately provided, maximum production cannot prevail. The purpose of the present paper is to determine the extent to which it paid to give the cows additional feed.

The writers obtained a high correlation of practically 0·6 between increased yield and increased cost of production. In other words, the cost of producing 1 lb. of butterfat decreased as production increased.

A Study of the Fat-Globule Size in Milk. *M. H. Campbell.* 1932. *Univ. Vermont Agric. Exp. Sta. Bull.,* 341.—This is a complete and painstaking review of the whole subject which includes some useful additional observations by the author.

Environmental factors were found to effect the size of the fat-globules in milk. Injury, sickness and sudden changes of condition produced a marked increase in the fat-globule size. Change of feed in some cases caused an increase in size and in some a reduction, while on others it had no apparent effect. Feeding of grain as compared to grass or the substitution of silage was without effect.

The fat-globules are usually largest during the first two weeks of the lactation with the most rapid rate of decline occurring during the next two months. Thereafter the decline of the rate in size is slow but usually continuous to the end of the normal lactation period.

From the evidence available, there is no doubt that the size of the fat-globule is primarily conditioned by heredity, and a number of factors appear to be involved in its transmission. There is a significant difference between the means of the Guernseys and Holsteins and between the Guernseys and certain cross cattle whose milk was also analysed in this respect.

Soft Curd Milk. *R. L. Hill.* 1931. *Bull.*, 227. *Utah Agric. Exp. Sta.*—Dr Hill is the human nutritionist at the Utah Agricultural Experiment Station. Having formed the opinion that the softness of the curd was a prime factor in the digestibility of milk by babies, he proceeded to investigate this characteristic so far as it concerned individual cows. In this paper is described the methods which he employed. Dr Hill found a wide variation in the curd character of milk from different cows from the same breed as well as certain differences between breeds. He found that the milk produced during the first month of a lactation has usually an abnormally hard curd but that this does not apply to the colostrum. The hard curd remains for a period of a little over a month. At the same time Dr Hill does not imply that a soft curd cow necessarily gives hard curd milk during this period. He thinks that the milk secreted by such a cow would be higher in its curd function immediately after calving than during the remainder of the lactation period. Towards the end of the lactation the curd again becomes somewhat harder, though in a few instances it becomes softer.

But all environmental causes appear to be overshadowed by the genetic. Dr Hill ran the curd test on the dairy cows at his experimental station for over a period of ten years. In every case it appeared to be an individual characteristic of the cow. Except for very sudden changes in the diet, the curd character of the milk is independent of the nature of the feed given. Neither was soft curd associated with low butter fat content, though the writer states that milk with a curd test of less than 20 grams (which is extraordinarily low) is usually decidedly low in fat content, although on the contrary he found some cows giving as high as 6 per cent. butter fat which had a curd test below this point.

The evidence which Dr Hill put forward in this bulletin so impressed the breeders of Ayrshires that steps have been taken in the United States for making soft curd tests on a large scale. The results of these are to be found in the Ayrshire Digest for July and August 1932, and in the *Ayrshire Journal* for September 1932. In the latter periodical is to be found a comparison of the curd tension of the Ayrshire with other dairy breeds. The Ayrshires included 915 individual cows in 25 herds, and the tests were conducted at the Standard Fat Testing Laboratory of the Baird Laboratories. The evidence would indicate that the Ayrshire breed contained a larger proportion of soft curd cows than did any of the other breeds tested at the Utah Experimental Station.

Dr Hill concludes his bulletin by citing case histories of babies fed on soft curd milk. In two cases the baby was reared from birth exclusively on soft curd milk. It would appear as though this new grade of milk were likely to be of considerable importance, and already arrangements have been made in various parts of the United States for the sale of this particular product. The value of soft curd milk, Dr Hill states, is not confined to infant nutrition alone; in cases of adult indigestion and gastric ulcers it has been used with remarkable results.

The Heat Coagulation of Milk: 1. Variations in the Compositions, Heat Stability, and other Tests of Milks from four Cows during the Course of a Lactation Period. *George E. Holm, B. H. Webb, and E. F. Deysher.* 1932. *Jour. Dairy Science, Volume* 15, *No.* 4, *pp.* 331-343.—The problem of the coagulation of milk in heat is an important one and one about which we may expect to hear more in the near future. Although the present authors worked on the milk of only four cows, they found that each of the individual milks retained fairly constant values in many of the tests, and that each value was characteristic for each cow.

Further investigation would appear likely to show that there is a genetic origin for this important difference.

Horses

Blood Grouping in Man and Animals with Special Reference to its Occurrence in the Equine. *J. Anderson.* 1932. *Vet. Rec.*—The writer briefly reviews the whole question of blood grouping in man, starting with the work of Landsteiner in 1900. It was in 1907 that the first examination of the blood of horses was made in this respect by Hektoen, but nothing definite was found. A series of investigations from 1920 to 1930 by various experts established the fact that certain blood groups definitely existed, but that a significant percentage of horses could not be easily classified in this respect. The author of this paper made a further investigation with the bloods of Shetland ponies and Clydesdales. While 87 per cent. of the horses he examined fell into the main groups, the remainder did not fit in to the existing scheme. A certain number of horse bloods contained neither agglutinogen nor agglutinin. The writer therefore concludes that as regards the specificity of the blood reactions, the horse is less highly developed than man. Accordingly, the possibility of using blood group reactions as a means of differentiating would not appear to be of any great value.

On the whole the evidence is in favour of the occurrence of blood groups in cattle, and the existence of three groups in sheep and swine would also seem to be proved. The possibility of distribution of blood groups appears to be more definite in cattle, sheep and pigs than in the horse.

Blood grouping has a double practical significance. In the first place, in man especially, knowledge of the blood groups enables blood transfusion to be successfully carried out. In animals, however, there is not much resort to this practice. From the few records in existence it appears to have been done successfully without reference to iso-agglutination reactions. The second aspect is the hereditary one, where the parentage may be determined by the blood groupings of the progeny. It would appear unlikely that this would become a matter of importance in the horse owing to the difficulty of differentiating the groups. Whether the method could be successfully applied to cattle, pigs and sheep remains to be seen.

Pigs

Inheritance of Whorls in the Hair of Swine. *J. E. Norby. Jour. Hered., Volume* 23, *No.* 10, *pp.* 397-404.—The whorl in the hair of a pig is in this country often called a "rose." If a pig has it, as often as not it will be found on the rump along the spinal column. It may, however, occur on the neck, the loin, the under-line, or the head of the pig.

For some time it has been recognised that this rose is definitely of a hereditary nature, but the mode of inheritance had not been properly "taped." The point which has proved a stumbling-block to many investigators is that while pigs without a rose can give progeny with a rose it does not always hold good that two pigs each with a rose mated together will produce progeny all of which exhibit a rose. Dr Norby explains this phenomenon on a basis of the effect of two dominant pairs of factors. Each of these factors must be present in the heterozygous or the homozygous condition before the whorls are produced.

In order to eliminate this defect, the writer states that it is imperative to discard both the sire and the dam of the pigs that have whorls. When a smooth-haired boar mated to a smooth-haired sow sires pigs with whorls, the boar is often given the blame for producing the whorls. As a matter of fact he is probably not more responsible than the sow, quite irrespective of the fact that these sows when mated to another boar might never have given any progeny with whorls. The writer strongly advises discarding from the breeding herd all the sows and most certainly all boars that have got whorls. He also states that it is almost as important to remove with equal diligence sows and boars with smooth hair that have produced progeny with the rose.

Poultry

Chick Mortality and Sex-ratio in the Domestic Fowl. *Dr Walter Landauer and Anna B. Landauer.* 1931. *Amer. Nat., Volume lxv, pp.* 492-501.—The evidence of the writer, as well as of previous authors whose work he reviews, is that deficiency of males at hatching time in poultry is significant. Assuming that at fertilisation there is equality of the sexes, as all authors seem to assume, then this significant deficiency of males amongst almost 68,000 chicks observed would suggest that there is a slight majority of males among the embryos which die. If any differential mortality occurs during the embryonic development of chickens, it is the male sex which suffers more. If harmful sex-linked factors are assumed to be the cause of higher male mortality in human infants, then a higher female mortality in animals like chickens, in which the females are the heterogametic sex, would be expected. Actually, however, in chickens as in man, the postnatal mortality is higher in males than in females. Thus the hypothesis that sex-linked factors play an important part in the differential mortality must be accepted with some reserve.

The writer states that from recent work with pigeons, the basal metabolism of males is more easily and to a greater extent upset by unfavourable conditions than is that of females. This finding points to the conclusion that in the male organism processes take place with a lesser degree of stability, which again would involve a greater amount of wear through necessary readjustments. It appears that there are no observations on record which are inconsistent with the assumption that the higher metabolic rate of males is produced by a more rapid and more continuous functioning of the organs and cells of the male body, and if the latter conclusion is valid, the comparison between the life span of organisms and of mechanical engines appears reasonable. Until new evidence is forthcoming, these sexual differences in the rate and stability of metabolism are offered as a working hypothesis for the understanding of differential mortality in the two sexes.

Linkage Tests in Poultry. 1932. *Walter Landauer. Biol. Gener., Bd. viii, Lieferung* 1, *pp.* 219-226.—It is important to establish whether certain genetic characters are linked in their transmission from one generation to another.

From the results contained in this paper it may be concluded that the creeper and normal skeleton compared to single and duplex comb are independent in their inheritance, so also are frizzled and normal plumage as regards single and duplex comb as well as bare neck and normal neck with frizzled and normal plumage. Neither is bare neck and normal neck linked to single and duplex comb.

The writer adds that duplex comb is determined by one factor, dominant to single comb. Probably there exists at least one modifier influencing the expression of the duplex condition.

Studies on the Creeper Fowl. The Early Development and Lethal Expression of Homozygous Creeper Embryos. 1932. *Walter Landauer. Jour. Genetics, Volume* 25, *No.* 3, *pp.* 367-394.—The dominant factor responsible for the traits of the Creeper fowl has a recessive lethal action. That is to say that Creeper fowls mated togther throw fowls with normal skeleton. Homozygous Creeper embryos usually die at the beginning of the fourth day of incubation, but in rare instances such embryos may live until shortly before hatching time. The rest of the paper deals with the development in the egg of the homozygous creeper embryo.

ANIMAL NUTRITION

Rolled *v.* Whole Oats as a Feed for Draft Colts. *A. B. Caine, Proc. Amer. Soc. Animal Production,* 1931 (*January* 1932), 200-204. (*Iowa State Coll.*)—The value of rolled oats as compared to whole oats as a supplement to wheat bran, salt and a mineral mixture and mixed hay as a feed for draft colts was determined. Results after two years showed that colts fed rolled oats made larger daily gains than those fed whole oats, and appeared to be fatter at the end of the test. Less feed was required per lb. of gain when rolled oats were fed.

Heavy Feeding of Cotton-seed Meal to Dairy Cattle. *L. A. Moore and C. F. Huffman. Proc. Amer. Soc. Animal Production,* 1931 (*January* 1932), 150-152. (*Michigan Exp. Stat.*)—Previous work has indicated that "cotton-seed meal injury" in cattle is due to nutritional deficiencies resulting from a lack of a factor or factors carried in good quality hay. The effects of feeding cotton-seed meal in large amounts have been determined on calves placed on experiment at 90 days of age. Five animals received cotton-seed meal and five linseed meal in addition to corn silage and timothy hay. The animals continued on these rations for 6 years and through 3 generations. So far the second and third generation animals are progressing satisfactorily. The meal used has been toxic to growing pigs at a 20 per cent. level. Two heifers fed 25 per cent. of dry matter as raw cotton-seed meal have not shown symptoms of cotton-seed meal injury. The experiments support the conclusions of previous work.

The Use of Cotton-seed Meal in Feeding Dairy Cattle. *A. H. Kuhlman, E. Weaver and W. D. Gallup. Proc. Amer. Soc. Animal Production,* 1931 (*January* 1932), 144-149. (*Oklahoma A. and M. Coll.*)—The nutritional limitations of cotton-seed meal for dairy cattle have been studied over a period of 4 years through observations of growth, reproduction and lactation when fed unlimited amounts of cotton-seed meal, prairie hay and salt as supplements when receiving milk or as the main ration. Untreated and autoclaved cotton-seed meal have been used, with and without the addition of carbonate of lime, iron sulphate, or both. All animals were tested for contagious abortion, 3 reactors being isolated. No advantage has been observed in the case of autoclaved meal over the untreated meal in growth or milk production. Twenty-eight calves have been raised to the age of 6 months or more, including second generation calves. Growth has been slow to fairly good. Nineteen animals have passed through the first generation on an average consumption of 6 lb. of cotton-seed meal and 10·6 lb. of hay per day. Eighteen animals have so far calved once, 8 twice, and 1 three times. Parturition was normal and rapid and lactation successful. Thirteen out of 28 calves died, 5 from effects not attributed to cotton-seed meal; 6 calves lost were from 8 rapidly growing heifers started at about 1 year of age. The results indicate that a ration adequate for fair growth may not be sufficient for rapid growth and reproduction, or they may indicate an influence of a poor grade of hay. To show possible deficiencies in the meal, beet pulp was substituted for prairie hay, with a resulting nutritional failure. Cod-liver oil caused immediate recovery.

Molasses-alfalfa Supplement for Fattening Yearling Cattle. *E. A. Trowbridge and H. C. Moffett. Proc. Amer. Soc. Animal Production,* 1931 (*January* 1932), 182-184. (*Univ. Missouri.*)—Cotton-seed cake with a mixture of alfalfa, meal, black strap molasses, reground oat feed was compared with cotton-seed meal as a supplement to shelled corn for fattening steers on blue grass pasture. Cattle getting a supplement to corn made more rapid gains and required slightly less feed per unit of gain during the first 56 days than those getting no supplement. Cattle getting cotton-seed cake gained 10 per cent. more and consumed slightly less feed per unit of gain during the first 56 days than those getting the mixed supplement. During the last 112 days all animals received a supplement and showed little difference in rapidity of, and feed required for, gain.

Sesame Meal *v*. Cotton-seed Meal and Peanut Meal for Lambs. *R. F. Miller. Proc. Amer. Soc. Animal Production*, 1931 (*January* 1932), 223-226. (*Univ. California.*)—The nutritive value of sesame meal for fattening lambs was compared with that of cotton-seed meal and peanut meal as supplements to barley and Sudan hay. There was a slight advantage in sesame meal over the other meals in the daily gain and economy of gain, and no noticeable difference in the finish of the carcasses.

Iodine Tolerance of Sheep and Lambs. *S. Weiser and E. Véghelyi. Fortschr. d. Landwirtsch*, 1932, *7*, 289-291. (*Roy. Hung. Animal Physiol. Inst., Budapest.*)—A herd of 474 merino sheep in a district very low in iodine supply, was divided into two groups, normally fed or given 4·40 mg. iodine per head per day and observed through three generations. There were no harmful effects, weaning weight of lambs was higher in the iodine group and wool yield was increased by 10·6 per cent. The iodine content of milk and wool was greatly increased.

Swine Reproduction in Relation to Nutrition. *A. G. Hogan. Univ. Missouri, Coll. Agric., Agric. Exp. Stat., Res. Bull. No.* 168, *May* 1932.—Where breeding sows were reared under experimental conditions and fed on ordinary pig-meals with varying protein and mineral supplements, their litters did not attain normal weights. It was suggested that the concentrates used were inadequate for swine over a prolonged period of time. No evidence was obtained that the unfavourable effects observed were due to a lack of exercise, sunlight, vitamin C, or to the ratio of lime and to phosphorus. Special precautions to prevent anæmia had no apparent effect on the rate of growth or on the appearance of the pigs.

The Calcium Requirement of Brood Sows. *A. G. Hogan. Univ. Missouri, Coll. Agric., Agric. Exp. Stat., Res. Bull. No.* 167, *May* 1932.—Experiments conducted on breeding sows during the years 1924-29 demonstrated that the feeding of a ration low in calcium produced poor farrowing results. During the years 1924-26 only one litter out of six was actually reared to weaning age, and these pigs had to be fed on cow's milk from the third week onwards and only weighed 17·2 lb. at weaning (8 weeks). Even on supposedly adequate rations the results obtained were not good, and when rations high in calcium were fed the results were as disastrous as those obtained on a ration low in calcium. The data indicate that rations for breeding sows should contain not less than 0·4 per cent. of calcium. The two complete failures on rations high in calcium were explained as due to the presence of toxic impurities in the mineral mixture.

Value of Potato Pulp in Pig Feeding. *W. Stahl, A. Gohner and F. Barth. Ztschr. f. Schweinezucht*, 1932, *39*, 229-231. (*Res. Inst., Ruhlsdorf, Teltow.*)—Pigs receiving dried potato pulp in addition to a basal diet of 63 per cent. rye or barley, 10 per cent. herring meal, 25 per cent. earthnut meal, and 2 per cent. chalk did not grow so well nor were their appetites so good as when potato flakes or steamed potatoes were fed in addition to the basal diet.

Dried Sugar-beet Pulp for Pigs. *T. S. Wright. J. Minist. Agric.* (*Engl.*), 1932, *39*, 111-115. (*Harper Adams Agric. Coll., Newport, Salop.*)—A single pig-feeding trial is described in which dried sugar-beet pulp replaced sharps in a ration of barley meal, sharps, extracted soya-bean meal and minerals. At the beginning of the trial 30 per cent. sugar-beet pulp was fed, but owing to its laxative nature it was later reduced to 20 per cent. of the total ration, and the pigs fed thrice daily. Under these conditions the sugar-beet pulp gave satisfactory financial returns at prevailing prices, and no differences were noted in the quality of bacon produced.

Modern Poultry Feeding on the Experimental Farm. *T. Newman. Eggs*, 1932, *26*, 333. (*Rudgewick, Sussex.*)—Three groups of birds were fed the same protein and mineral mixture for 24 weeks.

Group 1 fed 40 per cent. bran laid 1429 eggs.
Group 2 fed 20 per cent. bran laid 1280, and
Group 3 fed 10 per cent. bran laid 1008 eggs.

The highest percentage of first-grade eggs was found in the 40 per cent. bran pen. In another experiment five pens of 20 Rhode Island Red pullets were fed a basal mash of bran 20 parts, middlings 40, maize 20, S.G. oats 10, and meat and bone meal 10. Various mineral supplements were added, but the results indicate that a common salt supplement is as valuable for egg production as more complicated mineral mixtures.

Grit or Lime. *E. Mangold and H. Rüdiger. Arch. f. Geflügelk.*, 1932, Parts 1-2, 1-24. (*Agric. Coll., Berlin.*)—Eight commercial types of grit and lime were tested with regard to their behaviour in the digestive tract of fowls in a long-period experiment on 4 Leghorn and 4 Rhode Island hens. It was found that some types of material sold as grit, on account of their solubility in the digestive juices, do not perform any function as grit, and it is pointed out that the trade must distinguish between substances capable of acting as grit and those which act as mineral supplements.

Rearing Chickens on all Mash Rations. *H. Engler. Die Tierwelt*, 1932, *22*, 625-628. (*Zofingen, Switzerland.*)—Observations were made on the effect of protein level on growth. Experiments were made with 576 chickens in 5 groups on all mash ration, the digestible protein of which varied from 10 to 18 per cent. The most economical level was shown to be 14 per cent. Very low protein levels caused poor growth and cannibalism. High protein favoured the development of rickets.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS, AND FERTILISERS IN SEPTEMBER, OCTOBER, AND NOVEMBER, 1932.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

Description	September			October			November		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*Cattle—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ..	50 11	45 7	..	49 6	43 5	..	50 5	44 3	..
Cross-bred (Shorthorn)	46 6	41 1	31 6	44 3	38 8	27 11	45 4	39 6	27 1
Galloway	42 6	39 0	..	38 0	35 5	..	41 6	37 8	32 6
Ayrshire	37 0	29 5	25 2	33 9	25 0	..	36 7	27 2	..
Blue Grey	..	..	..	..	..	..	..	..	..
Highland	..	..	..	40 6	..	..	..	..	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†Veal Calves	14½	4¾	..	14½	3¾	..	14¾	3½	..
†Sheep—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.
Cheviot	7½	6¾	5	7½	6¼	5	7½	5¾	5¼
Half-bred	7½	6¾	4½	7¾	6¾	4¾	8	6½	4¾
Blackface	7¾	7	5½	8	6¾	5¼	8	6¾	5½
Greyface	8	7¼	4¾	8	7	4¾	8¼	7¼	4¾
Down Cross	8½	7¼	4¼	8	7¼	4½	8¼	7	4½
†Pigs—	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.
Bacon Pigs	7 10	7 3	..	7 9	7 2	..	7 8	7 2	..
Porkers	8 6	8 0	..	8 6	7 10	..	8 4	7 8	..

* Live weight.

† Estimated dressed carcase weight.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description	September			October			November		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
Cattle—	Per head	Per head	Per head	Per head	Per head	Per head	Per head	Per head	Per head
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	15 12	12 8	10 5	15 15	12 2	8 11	15 8	11 14	7 10
Two-year-olds ..	19 12	16 4	13 10	18 19	15 15	11 14	19 2	15 8	10 17
Cross-bred (Shorthorn)									
Yearlings	14 1	11 3	9 18	14 3	10 9	8 6	14 0	10 14	7 2
Two-year-olds ..	18 18	15 3	13 0	17 14	14 4	11 1	18 4	14 4	10 2
Galloway :									
Yearlings	13 9	10 18	..	13 3	11 0	..	13 9	11 10	..
Two-year-olds ..	16 10	..	..	18 8	15 10	..	25 4	15 0	..
Ayrshire :									
Yearlings	11 0	7 0	..	11 16	10 5	..	10 14	..	..
Two-year-olds ..	..	..	..	14 13	12 10	..	..	..	..
Blue Grey :									
Yearlings	14 10	10 10	..	16 0	..	..	14 0	..	..
Two-year-olds ..	..	..	..	17 0	..	..	..	..	..
Highland :									
Yearlings	10 5	6 15	..	9 3	6 17	5 0	8 15	6 11	4 0
Two-year-olds ..	..	..	..	11 15	8 18	7 0	10 15	9 11	6 10
Three-year-olds ..	..	..	..	13 13	11 5	..	13 13	10 5	..
Dairy Cows—									
Ayrshire :									
In milk	25 13	18 18	12 0	26 3	18 7	12 13	25 8	18 1	11 16
Calvers	26 10	18 16	13 14	24 3	17 15	13 18	25 7	18 5	13 14
Shorthorn Cross :									
In milk	29 2	20 14	11 0	28 3	20 6	..	28 5	20 14	..
Calvers	26 19	19 5	15 5	27 7	18 13	15 0	27 4	19 2	15 16
Sheep—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Cheviot Hoggs ..	20 0	13 0	..	30 0	17 0	..	17 9	16 0	..
Half-bred Hoggs ..	..	..	..	39 0	25 0	..	20 11	17 0	..
Blackface Hoggs ..	..	..	..	20 2	12 9	..	16 7	11 6	..
Greyface Hoggs ..	..	..	..	24 8	17 8	..	26 10	18 10	..
Down Cross Hoggs	..	..	..	21 6	17 6	..	25 0	20 0	..
Pigs—									
(6 to 10 weeks old)	20 11	12 11	..	20 4	13 0	..	20 2	12 1	..

DEAD MEAT : Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(*Compiled from Returns received from the Department's Market Reporters*)

DESCRIPTION	QUALITY	SEPTEMBER			OCTOBER			NOVEMBER		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb *d.*	per lb. *d.*	per lb. *d.*
BEEF :—										
Home-fed—										
Bullock or Heifer ..	1	8⅝	8⅛	9	8	7¼	9	7⅝	7	8¾
	2	8	..	8⅛	7⅜	..	8	6⅞	..	7¾
Bull	1	6⅞	6⅜	6	6¾	6	6	6¼	5¾	5¾
	2	6⅛	6	5½	6	5	5½	5½	4⅞	5¼
Cow	1	5⅞	5⅝	5½	5⅝	5½	5¼	5¼	5	5
	2	5⅛	..	4¾	4⅞	..	4¼	4½	..	4
Irish—										
Bullock or Heifer ..	1	..	..	8	..	..	7½	..	..	7
	2	..	..	7⅜	..	..	6¾	..	..	6¼
Argentine Frozen— Hind Quarters ..	1	4⅛	5⅛	..	4	4¾	..	4¼	4¼	..
	2	..	3½	..	..	3⅜	..	..	3½	..
Fore ,, ..	1	3⅛	3⅜	..	3	3¼	..	3⅜	3¼	..
	2	..	2½	..	..	2⅜	..	..	2¾	..
Argentine Chilled— Hind Quarters ..	1	6⅝	6½	6⅝	6½	6¼	6⅝	6¾	6½	6⅜
	2	..	5⅞	6	..	5½	6	..	5¾	5⅞
Fore ,, ..	1	3¾	3½	3¼	3⅝	3⅜	3¼	4¼	4	3⅞
	2	..	3	3	..	2⅝	3	..	3½	3¾
Australian Frozen— Hind Quarters ..	1	..	..	3⅞	..	..	3⅝	..	..	3⅞
	2	..	..	..	..	..	..	..	..	..
Crops	1	..	..	2⅞	..	..	2¾	..	..	3
	2	..	..	..	..	..	..	..	..	..
New Zealand Frozen— Hind Quarters ..	1	..	..	3¾	..	..	3½	..	..	3⅞
	2	..	..	..	..	..	..	..	..	..
Fore ,, ..	1	..	..	2¾	..	..	2½	..	..	3
	2	..	..	..	..	..	..	..	..	..
MUTTON :—										
Hoggs, Blackface ..	under 60 lb.	8	7⅞	6⅞	7⅝	7⅛	6½	7¼	7¼	6⅜
	60 lb. & over	7½	..	6½	7⅛	..	6¼	6¾	..	5⅞
,, Cross ..	under 60 lb.	8	7⅞	6⅞	7⅝	7⅛	6½	7¼	7¼	6⅜
	60 lb. & over	7½	..	6½	7⅛	..	6¼	6¾	..	5⅞
Ewes, Cheviot ..	1	..	4⅝	5⅛	..	3⅞	4⅝	..	4¼	5
	2	..	..	4½	..	..	4⅛	..	..	4¾
,, Blackface ..	1	5¼	4⅝	5⅛	5	3⅞	4⅝	4¾	4⅜	5
	2	5	..	4½	4½	..	4⅛	4¼	..	4¾
,, Cross	1	4¼	4⅝	5⅛	4	3⅞	4⅝	4	4⅜	5
	2	4	..	4½	3½	..	4⅛	3½	..	4¾
Argentine Frozen ..	1	..	..	3	..	..	3	..	..	3⅝
	2	..	..	..	..	..	..	..	..	..
Australian ,, ..	1	..	3⅝	3	..	4	3	..	4½	3⅝
	2	..	2⅝	..	..	2½	..	..	3½	..
New Zealand ,, ..	1	..	..	3½	..	..	3½	..	..	3⅞
	2	..	..	3	..	..	3	..	..	3½
LAMB :—										
Home fed—	1	9	..	8	..	..	7⅜	8	..	7⅞
	2	8½	..	7½	..	..	7	..	..	7½
New Zealand Frozen	1	..	5⅝	5⅜	..	5¾	5½	..	6¼	5¾
	2	..	4½	5⅛	..	4⅜	5⅛	..	5¼	5
Australian ,, ..	1	..	..	5	..	..	4⅞	..	..	5½
	2	..	..	..	..	..	..	..	..	5⅛
Argentine ,, ..	1	..	..	5⅛	..	..	4⅞	..	..	5½
	2	..	..	..	..	..	..	..	..	..

EGGS : Monthly Average Wholesale Prices at Aberdeen and Glasgow.

PROVISIONS : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	DESCRIPTION	QUALITY	SEPT.	OCT.	NOV.
			s. d.	s. d.	s. d.
ABERDEEN	Country .. .. per doz.	1	1 6	1 9	2 3
		2	1 5	1 8	2 1
	Duck .. .. ,,	1	1 7	1 9	2 2
		2	1 6	1 8	1 11
GLASGOW	Country .. .. per doz.	1	1 10	2 0	2 5
		2	1 8	1 11	2 1
	Northern Ireland per 120	1	17 6	19 6	23 9
		2	16 6	18 2	22 2
	,, (Cold Stored) ,,	1	11 10	11 10	12 6
		2	11 1	11 6	12 0
	,, (Duck) ,,	1	13 0	13 4	15 8
	Irish Free State .. ,,	1	14 9	16 4	21 5
		2	13 11	15 9	20 4
	,, (Cold Stored) ,,	1	..	12 2	12 1
	,, (Duck) ,,	1	12 4	12 8	15 4
	Australian .. ,,	1	..	14 5	14 5
		2	..	13 11	13 11
	Belgian .. .. ,,	1	13 0	14 0	18 3
	Danish .. .. ,,	1	14 1	14 11	19 10
	,, (Pickled) .. ,,	1	..	10 9	11 7
	Polish .. .. ,,	1	8 6	9 5	10 10
		2	7 5	8 6	9 2
	Swedish .. .. ,,	1	..	14 11	..

DESCRIPTION	QUALITY	SEPT.	OCT.	NOV.
		s. d.	s. d.	s. d.
BUTTER :				
Irish Creamery .. .. per cwt.	1	115 3	111 9	106 8
,, (unsalted) .. ,,	1	118 4	114 9	113 8
Australian .. .. ,,	1	112 6	110 9	100 0
,, (unsalted) .. ,,	1	114 8	112 9	103 0
Danish .. .. ,,	1	128 3	121 0	125 10
,, (unsalted) .. ,,	1	132 3	126 3	131 2
New Zealand .. .. ,,	1	118 3	118 9	104 7
,, (unsalted) .. ,,	1	119 0	121 6	111 2
Siberian .. .. ,,	1	102 0	102 0	96 10
Swedish .. .. ,,	1	117 3	113 9	122 5
Latvian .. .. ,,	1	111 0	107 0	109 0
CHEESE :				
Cheddar .. .. ,,	1	78 3	85 6	94 0
,, ,,	2	66 0	73 0	72 10
Cheddar Loaf .. .. ,,	1	95 6	98 6	98 0
,, ... ,,	2	88 0	88 3	79 2
Dunlop .. .. ,,	1	77 0	84 0	86 10
,, ,,	2	71 0	74 0	72 0
Canadian .. .. ,,	1	72 3	76 0	75 10
New Zealand (White) .. ,,	1	71 6	73 0	73 0
,, (Coloured) ,,	1	67 3	67 9	69 7
HAMS :				
Irish (Smoked) .. .. ,,	1	167 0	162 0	135 0
,, ,, ,,	2	157 6	146 0	114 10
American (Long Cut, Green) ,,	1	85 0	87 4	84 10
,, (Short Cut) .. ,,	1	78 3	70 0	68 7
Canadian (Long Cut) .. ,,	1	83 4	84 6	77 7
BACON :				
Ayrshire (Rolled) .. ,,	1	98 0	95 6	90 0
Irish (Green) .. .. ,,	1	91 6	75 6	71 7
,, (Dried or Smoked) ,,	1	96 0	81 6	77 7
,, (Long Clear) .. ,,	1	84 6	80 6	75 2
Wiltshire (Green) .. ,,	1	92 0	83 0	82 0
,, (Dried or Smoked) ,,	1	98 0	89 0	88 0
American (Cumberland Cut) ,,	1	61 0	53 6	54 5
Canadian Sides .. .. ,,	1	71 0	58 6	59 0
Danish Sides .. .. ,,	1	73 6	61 6	62 0
Dutch (Green, Wiltshire Style) ,,	1	67 0	52 9	55 10
Polish (,, ,, ,,) ,,	1	65 4	52 0	55 7

FRUIT AND VEGETABLES : Monthly Average Wholesale Prices at Glasgow.

(*Compiled from Returns received from the Department's Market Reporter*)

DESCRIPTION		QUALITY	SEPTEMBER		OCTOBER		NOVEMBER	
FRUIT :—								
Apples—	per		s.	d.	s.	d.	s.	d.
English Cooking ..	cwt.	1	18	3	..		24	0
Irish ,, ...	,,	1	18	0	..		20	0
American	case.*	1	12	0	11	6	11	6
,, ...	barrel.†	2	27	11	27	3	27	2
Pears, Californian.. ..	case.*	1	19	0	16	5	14	7
Blackberries, ...	lb.	1	0	5¼	0	5¼	0	5
Damsons	,,	1	0	7	0	8	..	
Plums, British, Egg ..	,,	1	0	3	..		..	
Monarch	,,	1	0	5¾	..		..	
Prolific ..	,,	1	0	5½	..		..	
Victoria ..	,,	1	0	8	..		..	
VEGETABLES :—								
Beans—								
Dwarf	,,	1	0	2	0	2	0	8
Scarlet Runner ..	stone.	1	2	0	2	0	..	
Beet	cwt.	1	6	3	5	3	5	0
Brussels Sprouts ..	,,	1	4	10‡	18	0	12	5
Cabbage—								
Coleworts	dozen.	1	1	0	1	0	1	0
Red	,,	1	4	0	3	3	2	10
Savoy	,,	1	1	6	1	8	1	5
Carrots	cwt.	1	6	6	6	6	5	4
Cauliflowers—								
Broccoli, Cornish ..	dozen.	1	..		5	4	4	10
Other British	,,	1	3	5	4	0	4	4
Celery	bunch.	1	2	5	1	10	1	7
Cucumbers	dozen.	1	4	3	4	9	6	3
Greens ..	dozen bunches.	1	..		6	8	6	0
Leeks	,, ,,	1	2	9	2	6	2	5
Lettuce—								
Cos	dozen.	1	1	0	1	0	..	
Cabbage	,,	1	1	10	1	9	1	10
Onions—								
Spring	bunch.	1	0	3	0	5	0	6
Dutch	bag.§	1	5	7	7	9	8	10
Valencia	case.‖	1	7	8	8	9	9	0
Parsley	cwt.	1	13	0	11	6	10	10
Parsnips	,,	1	9	8	8	6	7	5
Peas	,,	1	23	0	..		..	
Radishes	dozen bunches.	1	1	3	1	3	1	3
Rhubarb	cwt.	1	4	0	4	0	..	
Spinach	stone.	1	4	0	4	0	3	11
Tomatoes—								
Scottish National Mark								
"A.A."	lb.	1	0	6½	0	7¼	0	7¼
Other Scottish	,,	1	0	6	0	6¾	0	6½
Channel Islands ..	,,	1	0	3½	0	4¼	0	3¾
Dutch	,,	1	0	3	0	4	0	3¼
Canary	,,	1	..		..		0	4⅛
Turnips	cwt.	1	2	8	2	3	2	0
Vegetable Marrows ..	dozen.	1	4	0	3	5	3	0

* 40 lb. (approx.).
† 9 stone (approx.).
‡ per 20 lb.
§ 7½ stone (approx.).
‖ 9 stone (approx.).

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	First Earlies	Second Earlies	Late Varieties: Red Soils: Golden Wonder	Late Varieties: Red Soils: Other	Late Varieties: Other Soils: Golden Wonder	Late Varieties: Other Soils: Other
		SEPTEMBER					
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Aberdeen, per ton	1	..	3 2 6	..	..	..	..
Dundee ,,	1	..	3 1 3	..	..	..	..
Edinburgh ,,	1	2 15 0	2 15 0	..	..	..	..
Glasgow ,,	1	2 10 0	3 2 6	..	..	..	3 0 0
		OCTOBER					
Aberdeen ,,	1	..	..	..	..	4 10 0	2 18 2
Dundee ,,	1	..	..	..	..	..	2 15 0
Edinburgh ,,	1	..	2 13 4	5 3 4	3 14 2	4 0 0	2 5 0
Glasgow ,,	1	..	2 5 0	..	..	4 3 4	2 11 3
		NOVEMBER					
Aberdeen ,,	1	..	..	..	..	4 10 0	2 12 0
Dundee ,,	1	..	..	..	..	..	2 11 0
Edinburgh ,,	1	..	1 10 0	4 8 0	2 18 0	3 8 0	1 14 0
Glasgow ,,	1	..	2 1 6	..	..	4 10 0	2 10 0

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	Roots: Carrots	Roots: Yellow Turnips	Roots: Swedes	Hay: Rye Grass and Clover	Hay: Timothy	Straw: Wheat	Straw: Barley	Straw: Oat	Moss Litter
		SEPTEMBER								
		s. d.	s. d.	s. d	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
*Aberdeen, per ton	1	..	..	..	50 0	..	..	..	25 0	..
†Dundee.. ,,	1	..	15 0*a*	..	70 8*b* 55 0*c*	..	57 6	..	57 6	51 0*d*
‖Edinburgh ,,	1	..	..	..	50 6*c*	..	38 9	..	38 2	..
*b*Glasgow ,,	1	..	..	..	56 3	61 3	43 2	..	38 2	32 6*e*
		OCTOBER								
*Aberdeen ,,	1	..	..	.	50 0	..	..	..	25 0	..
†Dundee.. ,,	1	..	15 6*a*	..	72 6*b* 55 0*c*	..	52 6	..	50 0	51 0*d*
‖Edinburgh ,,	1	..	..	..	57 6*b* 52 6*c*	..	40 0	..	37 6	..
*b*Glasgow ,,	1	..	..	..	55 0	60 0	42 6	..	37 6	32 6*e*
		NOVEMBER								
*Aberdeen ,,	1	..	..	..	50 0	..	..	..	25 0	..
†Dundee.. ,,	1	..	15 5*a*	17 0*a*	78 0*b* 58 0*c*	..	50 0	..	48 0	51 0*d*
‖Edinburgh ,,	1	..	..	..	53 0*b* 52 6*c*	..	38 6	33 2	36 0	..
*b*Glasgow ,,	1	..	..	..	55 0	60 0	42 6	..	37 6	31 9*e*

* Loose, ex-farm.	*a* Delivered in town.	*d* Dutch moss litter, ex quay.
† Baled straw, delivered.	*b* Baled and delivered.	*e* Home moss litter, in 1½-cwt. bales.
‖ Bunched straw, delivered.	*c* Delivered loose.	

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	SEPTEMBER		OCTOBER		NOVEMBER	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.
Linseed Cake—						
Home	8 3 9	8 5 0	8 3 9	8 2 6	7 17 0	7 15 0
Foreign	7 17 6	..	7 17 6	..	7 15 6	..
Decort. Cotton Cake	7 16 3	..	7 18 2	..	7 11 9	..
Soya Bean Cake	8 10 0	..	8 10 0	..	8 2 3	..
Undecort. Cotton Cake—						
Egyptian	5 15 0	5 15 0	5 8 9	5 7 6	5 8 6	5 8 6
Coconut Cake	8 3 9	..	8 5 0	..	8 3 0	..
Palmnut Kernel Cake	7 14 5	..	7 13 9	..	7 10 0	..
Groundnut Cake, undecort.—						
(36/37 % Oil and Album.)	..	7 1 11	..	7 0 0	..	6 18 6
(48/50 % do. do.)	..	7 16 3	..	7 18 9	..	7 12 0
Maize Germ Cake, Home	7 11 7	..	7 17 2	..	7 11 3	..
Maize Germ Meal	6 0 4	..	5 18 9	..	5 16 6	..
Rice Meal	5 13 9	..	5 13 2	5 12 6	5 8 0	5 10 8
Bean Meal	9 8 2	8 16 3	9 2 6	8 17 6	8 19 9	9 4 0
Barley Meal	7 13 2	7 6 3	7 4 5	7 5 0	7 0 6	7 2 0
Fish Meal	14 11 3	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
Maize Meal—						
Home manufactured	6 5 0	6 5 0	6 0 0	6 3 9	5 17 0	6 2 0
South African (Yellow)	5 18 9	5 16 3	5 12 2	5 12 6	5 8 3	5 10 8
,, (White)	5 17 1	..	5 14 5	..	5 13 2	..
Locust Bean Meal (Fine)	6 17 6	6 1 3	6 17 6	6 0 0	6 10 0	5 18 6
Maize Gluten Feed (Paisley)	5 15 0	..	5 16 11	..	5 17 0	..
Maize—						
River Plate	5 7 10	5 8 9	5 2 4	5 3 9	4 19 6	5 1 0
African (Flat)	5 15 0	..	5 13 9	..	5 10 6	..
Oats—						
Scottish	7 8 9	7 0 0	7 8 9	6 11 11	7 4 0	6 7 0
River Plate	6 10 8	6 8 4	6 6 11	6 5 0	6 1 9	6 4 0
Canadian, No. 2	7 11 8	..	7 3 9	..	7 5 0	..
,, No. 3	7 5 11	..	7 0 8	..	6 19 6	..
Barley, Feeding (Home)	7 10 0	6 10 0	7 8 9	6 11 3	6 19 0	6 7 0
Wheat—						
Home	7 13 9	6 18 9	7 6 3	6 11 3	6 19 0	6 3 0
,, (Poultry)	7 5 0	..	6 9 5	..	6 13 0	..
Imported	7 1 7	6 6 3	6 10 11	6 0 0	6 15 3	5 19 0
Middlings (Fine Thirds or Parings)	7 14 5	7 5 0	7 8 5	6 17 6	6 11 6	6 6 0
Sharps (Common Thirds)	6 8 2	6 10 0	6 5 0	6 7 6	5 18 0	5 19 6
Bran (Medium)	6 7 10	6 7 6	6 4 1	6 7 6	5 18 0	5 17 0
,, (Broad)	6 6 11	7 1 8	6 4 5	7 0 0	5 18 3	6 13 0
Malt Culms	5 11 3	5 10 0	5 14 5	5 10 0	5 11 0	5 12 0
Distillers' Grains (Mixed, Dried)	..	8 2 6	..	8 2 6	..	7 11 0
Brewers' Grains (Dried)	6 12 2	6 5 0	6 10 8	6 5 8	6 7 3	6 3 0
Distillers' Malt Grains (Dried)	7 6 3	..	7 13 9	..	7 15 0	..
Crushed Linseed	13 0 0	..	13 10 0	..	13 10 0	..
Locust Beans (Kibbled and Stoned)	5 17 6	5 15 0	5 16 3	5 15 0	5 15 0	5 15 0
Beans—						
English	9 0 0	..	8 4 8	..	7 15 6	7 10 0
China	8 10 8	8 12 6	8 4 7	8 9 0	7 18 9	..
Egyptian	..	..	8 2 6	..	7 17 9	..
Rangoon (White)	6 14 5	..	6 10 8	..	6 7 3	..
,, (Red)	6 11 3	..	6 10 0	..	6 5 6	..
Pease—						
Karachi (White)	8 8 9	..	8 0 4	..	..	..
Calcutta (,,)	8 17 6	..	8 18 9	..	..	..
Feeding Treacle	5 0 0	5 10 0	5 2 6	5 8 9	5 0 0	5 5 0
Linseed Oil, per gall.	0 3 1	..	0 3 6	..	0 3 1	..

FERTILISERS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	SEPTEMBER		OCTOBER		NOVEMBER	
		Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	%	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d,	per ton £ s. d.	per ton £ s. d.
Nitrate of Soda *	N. 15·5	8 8 0	..	8 9 0	..	8 10 0	..
Sulphate of Ammonia (Neutral and Granular) * ..	N. 20·6	5 5 0	5 5 0	5 5 0	5 5 0	5 11 0	5 11 0
Calcium Cyanamide †	N. 20·6	6 15 0	..	6 17 6	..	6 17 6	..
Nitrochalk * ..	N. 15·5	7 5 0	..	7 5 0	..	7 5 0	..
Superphosphate ..	P.A. 13·7	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6
" ..	" 16·0	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
" ..	" 18·3	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
Ground Mineral Phosphate ‡ ..	P.A. 26	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6
" " " ..	" 34	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Kainit (in Bags) ..	Pot. 14	3 10 0	3 0 0	3 10 0	3 0 0	3 10 0	3 0 0
Potash Salts ..	Pot. 20	4 2 6	3 15 0	4 2 6	3 15 0	4 2 6	3 15 0
" " ..	" 30	5 11 3	5 5 0	5 11 3	5 5 0	5 11 3	5 5 0
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	9 19 5	9 10 0	9 17 6	9 10 0	9 17 6	9 10 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 17 6	11 10 0	11 15 0	11 10 0	11 15 0	11 10 0
Steamed Bone Flour	N. 0·8 P.A. 28	6 0 0	..	6 0 0	..	6 0 0	..
" "	N. 1 P.A. 60	..	5 10 0	..	5 10 0	..	5 10 0
Bone Meal (Indian)	N. 4 P.A. 20	7 0 0	..	7 0 0	..	7 0 0	..
" "	N. 4 P.A. 45	..	7 0 0	..	7 0 0	..	7 0 0
Potassic Mineral Phosphate	P.A. 18 Pot. 10	3 16 3	..	3 16 3	..	3 16 3	..
" " "	P.A. 18 Pot. 9	..	3 10 0	..	3 10 0	..	3 10 0
" " "	P.A. 20 Pot. 7·5	3 10 0	..	3 10 0	..	3 10 0	..
" " "	P.A. 20 Pot. 6	..	3 2 6	..	3 2 6	..	3 2 6
Potassic Slag	P.A. 12 Pot. 6	..	3 10 0	..	3 10 0	..	3 10 0
Basic Slag § ..	P.A. 13	..	1 17 6	..	1 17 6	..	1 17 6
" " ..	" 14	2 3 0	1 19 6	2 3 0	1 19 6	2 3 0	1 19 6
" " ..	" 15	2 7 0	2 1 6	2 7 0	2 1 6	2 7 0	2 1 6
" " ..	" 15·75	2 10 0	..	2 10 0	..	2 10 0	..
" " ..	" 16·5	2 13 0	..	2 13 0	..	2 13 0	..
" " ..	" 17·5	2 16 0	..	2 16 0	..	2 16 0	..

Abbreviations:—N.=Nitrogen; P.A.=Phosphoric Acid; Pot.=Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

‡ 90 per cent. fineness through prescribed sieve.

§ Glasgow:—F.o.r., in 6-ton lots, 80 per cent. citric soluble phosphate; Leith:—6d. per ton extra, carriage paid to Border stations.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1932

Collected 4th June 1932 (and comparison with 1931)

CROPS

DISTRIBUTION	1932	1931	INCREASE		DECREASE	
	Acres	*Acres*	*Acres*	*Per Cent.*	*Acres*	*Per Cent.*
TOTAL AREA (excluding WATER)	19,069,007	19,069,007	..	..	..	..
MOUNTAIN and HEATH LAND used for GRAZING (*b*)	10,368,178	9,497,263	870,915	9·2	..	..
TOTAL ACREAGE under CROPS and GRASS	4,622,217	4,632,200	..	..	9,983	0·2
ARABLE LAND	3,046,163	3,051,930	..	..	5,767	0·2
PERMANENT GRASS (*a*) For Hay	166,454	165,643	811	0·5	..	..
PERMANENT GRASS (*a*) Not for Hay.. ..	1,409,600	1,414,627	..	..	5,027	0·4
TOTAL ..	1,576,054	1,580,270	..	..	4,216	0·3
Wheat	52,072	50,024	2,048	4·1	..	..
Barley (including Bere)	68,868	87,900	..	..	19,032	21·7
Oats	867,374	834,687	32,687	3·9	..	..
Mixed Grain	1,613	2,044	..	..	431	21·1
Rye	2,624	3,162	..	..	538	17·0
Beans (to be harvested as Corn)	2,737	3,311	..	..	574	17·3
Peas	505	420	85	20·2	..	..
Potatoes	148,539	128,102	20,437	16·0	..	..
Turnips and Swedes	348,464	361,328	..	..	12,864	3·6
Mangolds	1,072	1,206	..	..	134	11·1
Sugar Beet	665	955	..	..	290	30·4
Cabbage	4,816	4,491	325	7·2	..	..
Rape	7,748	10,756	..	..	3,008	28·0
Vetches or Tares, for Seed	113	108	5	4·6	..	..
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	9,075	10,349	..	..	1,274	12·3
Carrots	501	353	148	41·9	..	..
Onions	132	142	..	..	10	7·0
Flax	13	64	..	..	51	79·7
Small Fruit	7,920	8,162	..	..	242	3·0
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER. For Hay	397,116	422,257	..	..	25,141	6·0
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER. Not for Hay ..	1,114,347	1,112,121	2,226	0·2	..	..
TOTAL ..	1,511,463	1,534,378	..	..	22,915	1·5
OTHER CROPS	3,374	3,287	87	2·6	..	..
BARE FALLOW	6,475	6,701	..	..	226	3·4
ORCHARDS (*a*)	1,000	1,061	..	..	61	5·7

LIVE STOCK

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural Purposes (including Mares for Breeding)	115,696	117,221	..	..	1,525	1·3
Unbroken Horses (including Stallions) One year and above	14,581	14,479	102	0·7	..	..
Unbroken Horses (including Stallions) Under one year ..	4,900	4,816	84	1·7	..	..
TOTAL ..	135,177	136,516	..	..	1,339	1·0
Other Horses	14,920	16,152	..	..	1,232	7·6
TOTAL OF HORSES ..	150,097	152,668	..	..	2,571	1·7
Cows in Milk	351,290	346,236	5,054	1·5	..	..
Cows in Calf, but not in Milk	53,458	51,702	1,756	3·4	..	..
Heifers in Calf	60,705	56,149	4,556	8·1	..	..
Bulls being used for Service	17,956	17,808	148	0·8	..	.
Other Cattle :—Two years and above	190,122	194,019	..	..	3,897	2·0
,, ,, One year and under two ..	300,184	293,315	6,869	2·3	..	..
,, ,, Under one year	259,548	249,618	9,930	4·0	..	..
TOTAL OF CATTLE (*c*) ..	1,233,263	1,208,847	24,416	2·0	..	..
Ewes kept for Breeding	3,442,613	3,414,990	27,623	0·8	..	..
Rams to be used for Service in 1932	96,133	94,483	1,650	1·7	..	..
Other Sheep :—One year and above	962,961	982,235	..	..	19,274	2·0
,, ,, Under one year	3,414,717	3,339,079	75,638	2·3	..	..
TOTAL OF SHEEP (*c*) ..	7,916,424	7,830,787	85,637	1·1	..	..
Sows kept for Breeding	19,772	20,425	..	..	653	3·2
Boars being used for Service	2,183	2,135	48	2·2	..	..
Other Pigs	143,370	139,043	3,727	2·7	..	..
TOTAL OF PIGS ..	165,325	162,203	3,122	1·9	..	..

(*a*) Any Crop or Grass grown in Orchards is also returned under its proper heading.

(*b*) Includes land in Deer Forests used or capable of being used for grazing. In previous years only the acreage i Deer Forests returned as used for grazing was included under this head.

(*c*) Including cattle and sheep grazed on Deer Forests.

ACREAGE under WHEAT, BARLEY (including BERE) and OATS in each COUNTY on 4th June 1932, with COMPARISON for 1931.

COUNTIES	**Wheat**		**Barley (including Bere)**		**Oats**	
	1932	1931	1932	1931	1932	1931
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
ABERDEEN	9	..	5,781	9,306	174,856	169,853
ANGUS	11,344	10,889	6,535	9,053	57,895	53,352
ARGYLL	5	1	580	609	13,947	14,118
AYR	632	710	18	17	33,288	33,517
BANFF	7	..	3,521	5,276	44,872	42,077
BERWICK	1,672	1,435	7,613	8,743	26,482	24,284
BUTE	8	..	1	7	3,950	4,184
CAITHNESS	..	..	331	348	25,558	25,175
CLACKMANNAN ..	190	151	26	51	2,714	2,514
DUMFRIES	41	46	76	42	32,188	31,981
DUNBARTON	342	288	20	2	5,639	5,614
EAST LOTHIAN ..	4,819	5,003	10,460	10,666	14,966	13,612
FIFE	11,321	10,898	7,292	8,552	40,442	37,714
INVERNESS	9	25	2,648	3,042	28,207	27,263
KINCARDINE	997	1,034	3,164	4,609	31,691	30,081
KINROSS	201	192	64	69	6,015	5,834
KIRKCUDBRIGHT ..	32	41	37	44	18,486	18,245
LANARK	1,674	1,668	46	50	32,953	32,548
MIDLOTHIAN	4,404	4,631	2,391	2,974	19,195	18,013
MORAY	674	642	4,403	6,916	26,210	23,132
NAIRN	32	..	897	1,687	6,901	6,028
ORKNEY	..	..	2,746	2,755	29,457	29,219
PEEBLES	7	4	14	92	4,978	4,982
PERTH	7,147	6,491	1,118	1,418	59,324	57,736
RENFREW	1,273	1,287	32	26	7,813	7,749
ROSS AND CROMARTY	829	568	2,963	4,793	32,747	31,522
ROXBURGH	935	859	4,295	4,720	22,074	20,903
SELKIRK	5	5	21	31	3,048	3,073
STIRLING	1,511	1,171	108	175	15,446	15,019
SUTHERLAND	..	..	130	158	6,399	6,381
WEST LOTHIAN ..	1,872	1,985	1,021	1,138	9,819	9,374
WIGTOWN	80	..	37	51	24,048	23,706
ZETLAND	..	..	479	480	5,766	5,884
TOTAL ..	52,072	50,024	68,868	87,900	867,374	834,687

ACREAGE under POTATOES, TURNIPS and SWEDES and SUGAR BEET in each COUNTY on 4th June 1932, with COMPARISON for 1931.

COUNTIES	Potatoes		Turnips and Swedes		Sugar Beet	
	1932	1931	1932	1931	1932	1931
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
ABERDEEN	8,096	6,968	74,226	75,410	1	2
ANGUS	19,760	17,168	26,552	28,097	43	68
ARGYLL	2,657	2,452	4,389	4,546	..	..
AYR	9,200	7,572	6,259	6,539	1	..
BANFF	1,762	1,602	17,911	18,081	1	5
BERWICK	2,306	1,989	16,942	17,775	1	22
BUTE	1,065	908	1,067	1,105	..	..
CAITHNESS	1,036	988	9,507	9,613	..	..
CLACKMANNAN ..	399	304	680	670	5	..
DUMFRIES	3,451	2,732	12,813	13,593	..	1
DUNBARTON	2,282	1,950	1,161	1,276	..	..
EAST LOTHIAN ..	8,497	7,584	10,671	11,488	71	18
FIFE	16,954	14,959	18,030	18,611	419	731
INVERNESS	4,585	4,467	7,977	8,072	..	..
KINCARDINE	4,539	3,558	13,894	14,355	13	..
KINROSS	1,266	1,021	2,005	2,197	..	..
KIRKCUDBRIGHT ..	1,428	1,185	7,836	8,254	..	..
LANARK	6,899	5,502	8,260	8,967	..	..
MIDLOTHIAN	6,367	5,550	7,791	8,778	6	13
MORAY	1,794	1,525	12,164	12,482	17	17
NAIRN	275	242	3,507	3,579	5	..
ORKNEY	2,015	1,914	12,204	12,285	..	..
PEEBLES	327	260	2,346	2,515	..	..
PERTH	18,818	15,690	20,124	21,599	56	78
RENFREW	3,302	2,764	1,658	1,846	..	..
ROSS AND CROMARTY	7,011	6,537	12,641	12,865	15	..
ROXBURGH	1,337	1,103	14,333	14,620	..	..
SELKIRK	138	115	1,857	1,738	..	..
STIRLING	3,609	2,970	3,081	3,231	..	..
SUTHERLAND	975	944	2,310	2,384	..	..
WEST LOTHIAN ..	2,612	2,235	2,760	2,986	6	..
WIGTOWN	1,820	1,429	10,563	10,758	5	..
ZETLAND	1,957	1,915	945	1,013	..	..
TOTAL ..	148,539	128,102	348,464	361,328	665	955

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1932, with COMPARISON for 1931.

COUNTIES	Rye-Grass and other Rotation Grasses and Clover				Permanent Grass			
	For Hay		Not for Hay		For Hay		Not for Hay	
	1932	1931	1932	1931	1932	1931	1932	1931
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
ABERDEEN ..	54,071	54,358	249,972	251,199	1,880	1,276	49,440	49,092
ANGUS	22,317	24,448	62,399	65,146	1,541	1,719	31,801	30,509
ARGYLL	12,067	12,274	15,693	15,497	14,849	14,616	48,029	50,257
AYR	25,425	27,575	48,863	47,260	20,729	21,858	158,161	157,589
BANFF	11,030	10,979	62,341	63,145	467	506	13,519	13,739
BERWICK ..	11,456	12,829	51,128	51,460	3,235	2,957	65,628	64, 744
BUTE	2,243	2,378	5,713	5,558	388	520	11,164	10,808
CAITHNESS ..	9,731	9,655	32,942	32,158	1,477	839	22,745	24,450
CLACKMANNAN ..	1,149	1,219	1,670	1,477	1,596	1,355	6,284	6,850
DUMFRIES ..	19,325	20,290	48,695	47,430	19,850	19,160	103,395	105,054
DUNBARTON ..	4,762	5,327	5,200	4,511	2,450	2,058	22,107	23,175
EAST LOTHIAN ..	8,622	9,520	17, 851	18,533	1,198	1,165	27,549	27,348
FIFE	24,431	27,123	30,883	31,245	4,318	4,748	78,126	79,448
INVERNESS ..	11,391	12,178	23,564	23,247	10,664	9,492	57,202	57,561
KINCARDINE ..	12,746	13,149	36,716	37,090	401	379	12,091	11,851
KINROSS	2,846	3,052	7,012	6,697	828	851	11,204	11,825
KIRKCUDBRIGHT	10,424	11,061	37,370	38,223	12,988	12,141	88,948	88,865
LANARK	29,305	30,905	37,134	33,131	13,039	13,598	104,199	107,517
MIDLOTHIAN ..	10,222	11,169	18,887	16,955	1,630	2,466	42,728	42,958
MORAY	6,404	6,639	35,347	35,489	144	259	8,275	8,358
NAIRN	1,775	1,793	9,557	9,063	103	34	1,840	2,543
ORKNEY	11,067	10,937	33,832	33,974	1,133	796	15,163	15,542
PEEBLES ..	2,513	2,665	10,244	9,470	1,204	1,428	28,855	29,015
PERTH	31,155	34,011	61,366	61,886	12,388	11,839	99,775	100,489
RENFREW ..	7,112	8,152	6,574	6,379	5,826	6,021	44,096	44,022
ROSS & CROMARTY	12,212	13,298	35,763	35,311	3,467	4,237	28,782	27,103
ROXBURGH ..	10,080	10,911	50,310	51,741	7,786	7,073	62,198	60,513
SELKIRK	1,364	1,449	6,750	6,795	2,095	2,191	14,549	14,416
STIRLING ..	9,314	10,542	9,630	10,264	8,324	8,958	55,812	54,777
SUTHERLAND ..	4,503	4,596	6,194	5,944	1,787	1,614	8,268	8,463
WEST LOTHIAN ..	6,155	6,793	4,988	4,741	932	1,293	22,683	22,314
WIGTOWN ..	8,086	9,308	49,037	50,483	5,631	6,082	53,342	51,070
ZETLAND ..	1,813	1,674	722	619	2,106	2,114	11,642	12,362
TOTAL	397,116	422,257	1,114,347	1,112,121	166,454	165,643	1,409,600	1,414,627

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1932, with COMPARISON for 1931.

COUNTIES	Horses *		Cattle †		Sheep †		Pigs	
	1932	1931	1932	1931	1932	1931	1932	1931
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
†ABERDEEN ..	21,458	21,635	173,088	170,732	429,432	411,076	20,017	19,953
†ANGUS	7,091	7,191	50,338	49,125	216,906	217,787	8,149	8,366
†ARGYLL	4,129	4,169	50,679	49,901	717,085	714,725	3,847	3,867
AYR	6,887	6,939	115,606	112,245	414,182	410,183	11,513	10,769
†BANFF	6,320	6,423	41,317	42,505	117,150	114,716	6,055	6,250
BERWICK ..	3,451	3,452	25,691	24,945	410,715	411,640	4,546	4,315
BUTE	936	939	9,133	9,128	45,176	42,689	595	599
†CAITHNESS ..	4,141	4,265	18,591	18,790	195,148	189,817	1,424	1,609
CLACKMANNAN ..	453	457	3,987	4,016	12,881	13,603	472	465
DUMFRIES ..	5,236	5,206	74,254	70,857	589,959	580,919	9,317	8,982
†DUNBARTON ..	1,197	1,210	13,539	13,424	72,266	70,444	1,318	1,272
EAST LOTHIAN ..	2,740	2,765	16,528	15,017	173,455	173,019	3,623	3,071
FIFE	6,681	6,712	48,555	46,139	164,742	161,919	8,623	8,639
†INVERNESS ..	5,865	5,750	42,883	42,716	506,648	503,941	1,885	1,980
†KINCARDINE ..	3,584	3,583	27,489	26,961	78,130	80,851	2,740	3,198
KINROSS ..	818	824	6,041	6,252	36,014	37,059	697	785
†KIRKCUDBRIGHT	3,450	3,476	60,921	58,576	402,886	400,761	11,767	11,042
LANARK	5,710	5,729	73,670	72,139	246,125	240,394	7,816	7,135
MIDLOTHIAN ..	2,650	2,693	18,999	18,301	202,392	200,891	13,291	12,988
MORAY	3,504	3,639	24,092	23,492	56,939	56,797	4,661	4,905
NAIRN	978	981	6,614	6,633	16,335	16,951	869	720
ORKNEY	5,500	5,474	36,217	36,594	69,537	68,680	1,718	1,936
PEEBLES ..	671	701	7,031	7,058	211,964	207,547	644	929
†PERTH	8,863	9,031	69,950	67,754	657,477	661,517	8,232	8,386
RENFREW ..	1,905	1,914	25,160	24,425	48,220	47,631	4,419	3,945
†ROSS AND CROMARTY ..	5,265	5,387	35,949	36,857	345,050	330,339	3,110	3,533
ROXBURGH ..	2,968	3,007	26,073	25,438	588,911	585,720	2,834	3,043
SELKIRK ..	475	477	4,071	4,013	191,635	187,123	380	385
STIRLING ..	3,035	3,098	34,054	33,236	132,137	130,053	2,843	2,799
†SUTHERLAND ..	1,655	1,697	8,375	8,611	211,700	214,243	430	417
WEST LOTHIAN	1,581	1,614	12,836	12,605	26,823	27,153	2,699	2,324
WIGTOWN ..	4,083	4,185	61,311	59,789	155,136	152,050	14,578	13,398
ZETLAND ..	1,897	1,893	10,221	10,573	173,268	168,549	213	198
TOTAL ..	135,177	136,516	1,233,263	1,208,847	7,916,424	7,830,787	165,325	162,203

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 131.

† Including cattle and sheep grazed on Deer Forests.

DEPARTMENT OF AGRICULTURE FOR SCOTLAND,
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THE LATE SIR J. ARTHUR THOMSON

The Department of Agriculture for Scotland learned with deep regret of the death of Sir J. Arthur Thomson, Emeritus Professor of Natural History in the University of Aberdeen. Apart from his valuable work in the field of zoological study, his services to science and to education as teacher, lecturer, and writer were outstanding. In him were combined, to a degree probably unsurpassed in any other man of his time, powers of keen observation, a philosophic breadth of view, and a gift of lucid expression that was often tinged with gentle humour and sometimes illumined by a flash of poetic inspiration.

Sir Arthur wrote occasional articles for some of the early numbers of this Journal, and thereafter the Department had the privilege of publishing a series of contributions, under the title "The Biologist on the Farm," which continued without interruption for twelve years, and ended only in January last, a few weeks before his death. These contributions, drawn from their author's wide and varied knowledge both of natural history and of other sciences, were characterised by many of the qualities that gave his writings their peculiar interest and charm. The Department believe that the readers of the Journal will share in this brief but grateful tribute to his memory, and in their sorrow that his pen, which wrote so much and so well, will write no more.

J. M. C.

YOUNG FARMERS' CLUBS

Professor J. A. S. WATSON, M.C., B.Sc.

School of Rural Economy, University of Oxford

ONE of the most interesting of recent developments in agricultural education in England is the rapid growth of the Young Farmers' Club movement. In many counties—in Northumberland, Durham, Essex, Devon, Sussex, Kent, and Yorkshire, to mention only a few—these clubs are already numerous, and are recognised as filling what was formerly a serious gap in the educational scheme. In many other counties the actual numbers are still small, but are growing. A careful census of the whole country, taken at the beginning of the present year, showed a total of 147 clubs in an active and flourishing condition, with a total membership of about three thousand. These figures represented increases of fully 50 per cent. in twelve months. The idea has also been taken up in Northern Ireland, and the movement there is already very vigorous. Several counties in Wales have made a beginning.

Although a few scattered clubs were in existence earlier, it was not until 1922 that the foundations of any widespread scheme were laid. In that year the late Lord Northcliffe started a number of clubs modelled on the type which had already proved its great value in the United States. At Lord Northcliffe's death in 1924 the Ministry of Agriculture assumed responsibility for the provision of advice, and appointed an organiser, and it continued until 1928 to give direct support. By this time there were some fifty active clubs in existence in the country, with about six hundred members.

In 1928 the National Council of Social Service, with the financial support of the Ministry, undertook the central administration, formed an Advisory Committee of interested persons and appointed an organiser. The Committee called together in 1929 the leaders of all existing clubs, and this meeting decided upon the formation of a National Association, to which the individual clubs might affiliate. In 1931 a further generous grant from the Carnegie United Kingdom Trust made possible a considerable increase in the headquarters staff, and somewhat later still the constitution was modified and the present National Federation, which is described below, came into being as an independent body.

THE CLUBS

Young Farmers' Clubs are open to boys and girls between the ages of ten and twenty-one. Their main object is educational. The internal organisation is as follows :—Each club elects, from among its ordinary members, a Chairman, Secretary, Treasurer, and Committee, and conducts its meetings and runs a considerable part of its business without outside help. An adult person acts as Club Leader, inspecting stock or plots at frequent intervals, examining record books, helping to arrange speakers for meetings, often acting as instructor in stock judging, and being available in all matters of difficulty. There is further a small Advisory Committee, including usually some local farmers, who assist in such matters as the purchase and sale of stock, and who are expected to see to the financial soundness of the concern.

The central feature of the club's work is the running, by each member, of some small agricultural enterprise—the rearing of a calf or a pig, the cultivation of a plot of vegetables, or the keeping of a small flock of poultry, a hive of bees, or a few rabbits. This enterprise is regarded throughout as a miniature business and not as a hobby, and every effort is made to maintain a business outlook with regard to it. The member is supplied at the outset with a record book, which, when complete, is at once a history of the enterprise and a complete cost account. In the case of a calf club, for example, the prime cost and date of purchase are entered ; the consumption of milk and other foods is recorded in detail, and in terms both of quantities and costs ; any ailments are noted, along with the treatment adopted. Figures are totalled and checked by the Club Leader month by month, and his observations are written in after each of his inspections. Finally, the book shows the price received on disposal, any awards won, and a statement of profit or loss.

The first question that arises in starting a live-stock club is that of raising the initial capital. The difficulty is of course greatest in the case of the most popular type—the calf club—where the amount required may run to three or four pounds per member, or, say, sixty or eighty pounds for a club of average size. Neither the County Federation nor the National Federation is in a position to provide finance, and indeed it is one of the fundamental ideas that the individual club should be responsible for its own affairs. In some cases the necessary initial loan has been raised by local subscription or has been made by a local benefactor ; in others the parents have subscribed the money ; in other cases again County Councils have provided the capital, either as a loan free of interest or partly as a loan and partly as an outright grant ; finally, funds have often been raised by means of a bank overdraft under the guarantee of the members of the Advisory Committee.

If the enterprises, as a whole, prosper during the first few years of the club's existence, the loan can be reduced or paid off entirely, because the club retains a small proportion—usually 10 per cent.—of the realised profits of the members. One large club in Sussex, which was financed by a bank, and which has specialized in the rearing of pedigree calves, has been highly successful financially, and showed, in its last balance sheet, a surplus of assets over liabilities of £327.

It is commonly found that local people—farmers, dealers, and butchers—are prepared to help clubs in their early stages by bidding something more than bare commercial values for the stock presented at the first one or two annual sales. A little planning and propaganda before the first sale have often been successful in putting a new club financially upon its legs.

Upon the whole, and although there are many individual examples of successful " mixed " clubs (where each member selects the particular kind of enterprise best suited to his tastes and circumstances), the task of the Club Leader is greatly simplified if all the members do the same thing. Moreover, in the latter case there is more chance of developing keen, friendly rivalry between members. Calf, pig, and poultry clubs have all proved pretty uniformally successful; horticultural clubs have succeeded in suburban areas, where the sale of vegetables and fruit is relatively easy to arrange, but in country districts the stock clubs are more popular. By far the greatest business difficulties have been met by the rabbit clubs owing to the extremely irregular market for pelts and rabbit wool.

A detail, but one of considerable importance, in connection with calf and pig clubs is the insurance of the stock. This is now most commonly arranged through the National Farmers' Union Mutual Insurance Society, which has taken a special interest in the business and offers favourable terms. Some of the larger clubs carry their own insurance, but experience shows that this is unwise, unless or until the club has succeeded in building up a fairly substantial reserve fund.

After stock keeping the most important among the activities of the livestock clubs is the training of the members in stock-judging. The standard method of training is first to teach the " points " of one or two classes of stock by going over individual animals, preferably with the help of a score card; the instructor later begins to draw comparisons, point by point, between two animals, and each member in turn is put through a similar exercise, while the others listen and criticise. Finally, a class of animals, ordinarily of four individuals, is placed in order of merit by the members, and each in turn gives verbal reasons for his or her decision.

Two criticisms have been made against this type of training, and each points to a possible pitfall. The one is that the task of placing four cows or calves in order of merit, and of giving detailed reasons, is one beyond the average capacity of a child of the age of say fourteen years or less; and that it is educationally unsound to set a series of problems, one after another, that are too difficult to be satisfactorily solved. The instructor must therefore be careful to suit the complexity of his tasks to the age and capacity of the individual members. For instance, while the older children are put through the whole performance with a class of four animals, the younger may be asked to compare them only in regard to one or two specified points ; or they may be asked to judge only two of the four animals presented, preferably those two which present the greatest contrasts.

The second criticism is that an elaborate training in stock-judging is liable to give the young person a wrong sense of proportion as between what may roughly be called showyard standards on the one hand and other measures of animal merit—such as milk recording, pig recording, litter testing, and carcase tests—upon the other. Moreover, there is the risk that the pupil will get the wrong notion of stock-judging as some kind of exact science capable of being reduced to precise rules and principles. Stock-judging training then must be balanced with more general instruction of a simple kind in other aspects of animal husbandry, and the instructor must never be dogmatic on points where there is room for difference of opinion.

Apart from these two dangers, which are both avoidable by the experienced Club Leader, stock-judging is a subject of great educational possibilities, and is so different from school work that it possesses a special attraction for many young people. It develops the powers of observation in a remarkable way ; it forces the vague and hesitant child to come to definite decisions ; and it provides opportunities for the pupil to describe what he has seen, and to argue for his own views. The performance of competitors in the stock-judging competitions—particularly their powers of expressing themselves in terse and lucid speech—forms an ample vindication of the training.

The ordinary evening or Saturday afternoon meetings of the clubs are devoted partly to routine business such as the checking of record books by the Club Leader and his observations upon the work of the members. For the rest they are devoted to social activities, to debates and discussions, and to definitely instructional talks on country affairs. Of the latter some deal with questions of immediate practical importance—the feeding of pigs or the ailments of calves—while others are devoted to subjects of a more general kind—trees, wild flowers, local geology, local history, the agriculture of other countries and so forth. For the more technical lectures most of the clubs depend largely upon the members of the County Agricultural staffs, and in this, as well as in other matters, the clubs owe a great deal to the County Agricultural Organisers.

Special occasions are made of the annual distribution of stock and of the annual Show and Sale. Some clubs or groups of clubs organise their own summer Shows (apart from Sales), and many County and District Show Societies now provide special sections for Young Farmers' stock and produce.

County Federations

The clubs are affiliated to the National Federation, either directly or, where this exists, through a County Federation. The club pays a small affiliation fee, in the first case to Headquarters only, and in the second to the County Federation as well. Each club elects a representative to the Committee of the County Federation, and this Committee elects its own President and Secretary.

Most of the County Federations are of very recent origin, but it is already clear that they will prove of great value. They arrange conferences and instructional lectures for club leaders, and organise combined rallies of the clubs at places of interest, such as the County Farm Institute or the local College of Agriculture. Other possible activities are the holding of County Young Farmers' Shows and Stock-Judging Competitions. A model set of Rules for County Federations has been drawn up by the National Federation.

The National Federation

The National Federation, with Headquarters at 16 Russell Square, London, is under the Presidency of Lord Burghley. The staff consists of a Secretary, a Chief Organiser, and two Assistant Organisers, of whom one is stationed in the North of England, and the other in the south-west. The Council of the Federation consists partly of members nominated by interested bodies, such as the Ministry of Agriculture and the Carnegie United Kingdom Trust, partly of members elected by a postal vote of the clubs and partly of co-opted members—the elected representatives of the clubs being a majority.

The Federation publishes a quarterly paper, *The Young Farmer*, which has now reached a circulation of 3000 copies. The Organisers' duties are to assist in the formation of new clubs, to visit and advise existing clubs, and generally to forward the movement. The Federation arranges annually two National Stock-judging Contests, for dairy cattle and poultry respectively, which are held at the London Dairy Show in October. Last year twenty-five teams competed in the former, and nine in the latter. So far these teams have represented individual clubs, but it will probably be necessary in future to restrict entries to one or two from each county. The federation also arranges annually the International Dairy Cow-judging Contest (which has been held in recent years at the Royal Show) for the *Daily Mail* Gold Challenge Cup, presented by the late Lord Northcliffe. These contests have become important features of the Shows at which they are held, and attract a great deal of public interest. The National Federation also awards annually a Challenge Shield to the most efficient Club in each of two distinct categories.

CONDITIONS FOR SUCCESS

Although failures of individual clubs have not been very numerous, they have occurred often enough to point some valuable lessons. The most important single factor is undoubtedly the efficiency of the Club Leader, and the necessary qualifications for this post are not always easy to find. The leader must have a good practical knowledge of the kind of enterprise that the club proposes to take up. He or she must be interested in young people and have a capacity for leadership ; discipline of a kind is very necessary, yet it must not savour strongly of compulsion. Finally, the person selected must have both the power and the inclination to give a very considerable amount of time to the work.

A good club leader has often succeeded in unpromising circumstances just as an unsuitable leader has sometimes failed under favourable conditions. Nevertheless, local circumstances must receive careful consideration. Areas of very large farms are difficult to organise, partly because the potential club members will be widely scattered, but also because many will be away from their homes, at boarding schools, during the greater part of the year. Districts of small farms present the easiest problem.

A second point is that a supply of good quality material—whether stock or land—should be ensured. The tendency with the average Young Farmer is to be somewhat too lavish in his agricultural methods, and it is best to give him the sort of raw material that will pay for care and attention. It is, for instance, rather a pitiful thing to find a calf feeding upon everything that is good and being groomed twice a day if it is obvious that it can never be anything but a " scrub."

THE VALUE OF THE CLUB MOVEMENT

The chief value of the organisation is that it provides a means of offering something of real value to a mass of young people who can otherwise hardly be reached by the existing machinery of agricultural education.

The technical training is necessarily limited in scope, but need not on that account be the less sound. More important, however, is the introduction which the members obtain to elementary notions of finance and accounts ; to the conduct of public business, to public speaking and to the organisation of their own affairs; most important of all is the development of a real co-operative spirit, which is a marked feature of the older and better clubs.

The club movement reacts beneficially upon other forms of agricultural education. The clubs provide many opportunities of picking out promising students for County Farm Institutes and Colleges. The leaving members are rarely content to leave unfilled the gap in their activities which the break involves, and tend to form themselves into Discussion Societies or to proceed to the organised Agricultural Classes which many Counties now provide. There is indeed a growing demand for some related kind of organisation which would carry on the work after the age of twenty-one.

ELECTRICITY IN MECHANISED FARMING

H. J. DENHAM, M.A., D.SC.

WITH the approaching completion of the " Grid " system the problem of rural consumption is becoming a matter for urgent consideration, and the following notes, which, it is hoped, will be regarded as strictly impartial, represent the experience which has been accumulated by the Institute for Research in Agricultural Engineering at Oxford in the course of its work in all parts of the country. This Institute has for some time past been largely concerned with the development of rural electrification. At the present moment the Institute is carrying out an intensive survey of the power requirements of farms in the area around Oxford served by three important supply companies, and is also carrying out detailed research work on a number of uses of electricity in agriculture.

At the same time, through its survey of mechanised farms, in which every new development of farming practice is intensively studied under working and strictly commercial conditions, the Institute has the opportunity of studying the whole question of the use of power in relation to modern farming technique ; the work of the Institute is not restricted to what may be termed " pioneer developments," but is also concerned with the needs of the average farm and the smallholding.

These notes, which are thus the result of a very widespread contact with the farming community, may prove somewhat damping to the supplier of electricity, who has at one time or another had to endure an almost excessive amount of optimistic propaganda on the future of electricity in farming, but at the same time it is hoped that they will lead to a somewhat saner point of view towards the problem in general.

Disappointment has been expressed in several quarters that more work has not been done by public bodies on the development of electricity in agriculture. It is hoped that the recent activities of the Electrical Development Association will go far to remove this reproach, but, while it is evident that intensive research is desirable on a number of applications of electricity in specialised provinces, the main problem which the farmer himself has to face is the cost of his power and the amount of capital which he would have to lock up in his plant.

Farming, to be successful, must be done on strictly business lines, with its expenses as carefully controlled as they are in any other manufacturing process, and the "intangible assets" which form one of the main claims for the superiority of electricity over other forms of power must be demonstrated to the farmer, just as they must be demonstrated to the industrial user, as clear and tangible results, before he will be willing to scrap existing equipment which, in his hands (although obsolete in design and often ruinous in appearance), still gives quite satisfactory results. A slight saving of convenience or labour is of little importance at a time when agricultural labour is still low priced by comparison with that of the more favoured urban population. Labour saving, indeed, in the country is a very complex problem : where the number of hands employed is governed by some particular process of outstanding importance, there is often little to be gained by making labour reductions on minor operations of casual occurrence.

Farms may most conveniently be discussed under two headings, the "extensive" and the "intensive." The former include the general farm which, if mechanised, is usually larger than 200 acres, as well as the specialised farm devoted to arable or grassland cultivation. The intensive group may cover such activities as dairying, fruit farming, market gardening, poultry, pig production and the like. The division between the two is not rigid. It must be at once admitted that extensive farming is perhaps the least promising opening for electrification. The tendency at the moment is towards greater and greater decentralisation of every process. Threshing, for instance, on the most economical basis, is now carried out in the harvest field, either by a "Combine Harvester Thresher" or by a separate machine. Hay may be baled from the windrow by a "Combine Baler" or swept with motor sweeps to a stationary baler, and the stackyard may soon be a thing of the past. Even milking, as in the Hosier system, may be done more profitably in many districts in the open with the movable milking bail rather than in the byre. The ultimate object of this decentralisation is the elimination of unnecessary movement and handling of material which, in the field as in the factory, is one of the keys to economical working.

To wire up a large modern farm in such a way that portable motors could be used wherever work is likely to be done must, by the very nature of the problem, involve a heavy capital outlay. That the farm should be completely wired seems to be a necessary consequence of electrification if the flexibility of working of the farm is to remain unimpaired—an essential factor if the farmer is to be able to take advantage of economic changes and trends. An outlying barn or an area of ground which is not easily connected up may prove the outstanding factor in the choice between the use of tractors or electric motors for the whole estate. The lack of flexibility of wiring systems—more rigid in this country than in any other by reason of the high standard required—quite apart from the question of their cost, makes electric power almost impossible on the extensive farm. The farmer who elects to adopt it becomes, by his decision,

> "Pre-destined to move,
> In a definite groove,
> Not even a bus but a tram."

The point which seems to be consistently overlooked in discussions on electrical farming is that the farm already possesses a completely satisfactory mobile power unit in the tractor. The modern tractor is an extremely reliable and efficient all-round machine, which will provide, apart from its traction, belt horse-power at a running cost of ¾d. per B.H.P. on paraffin and ½d. on heavy oil. In initial cost it compares well with the electric motor, if the cost of the connection to the supply mains is taken into account. It has the advantage of being able to move to the next job under its own power (and probably towing the machine to do the job as well), and it can plough round and round the field, which no trailing cable machine can do. This, of course, matters little in ploughing, since "one-way" ploughs are available; harvesting is impossible in any other way. The tractor has one disadvantage: it is uneconomic when running at a small fraction of its normal working load, and that normal working load (in the machines on the market at the moment) is too high for most of the old horse-drawn equipment; except when ploughing and performing other operations of cultivation the tractor is seldom working at its maximum load.

Turning to the farm buildings, which are yearly becoming a less important feature of the large farm, and which will become even less important if the threatened breakaway from the tradition of the stackyard takes place, the position as regards power supply is less clearly cut and depends again almost entirely on cost. The tractor is quite in its element in driving the general run of farmyard machines, and the cost, although not then the lowest of which it is capable, is still extremely low. The use of a machine for this purpose extends the number of hours in which it can profitably be used, and helps it to bear its share of the farm overheads. The portable internal combustion engine is equally in its element for this work, and it is as easy to adapt a small petrol engine to such a machine as an elevator as it is to adapt an electric motor. There is this distinction in practice: that it is easier to run a small machine at a constant speed with a fractional horse-power motor than it is with a small internal combustion engine running well below its peak load. The electric motor, in some instances, is favoured by its almost complete freedom from vibration.

In farms where electricity is available at a reasonable cost there is a good opening for the portable electric motor, particularly of the multi-spindle type. Farmers, in general, seem averse to the idea of unit motors except in special cases, and it would be sound practice, in many instances, to instal a larger motor of a standard type driving a line of shafting. The recent developments at Rothamsted, where the home farm has been electrified, will be of the greatest value in clearing up points of this nature.

It is sometimes said that, on the average farm, few of the machines of the food-preparing group are run for a sufficient number of hours in the day or days in the year to justify the installation of a separate motor to each machine. In general, the tendency is more and more for foodstuffs to be bought ready prepared from outside, and many machines are already standing idle. The advantages of " push-button " control are negligible in practice. The British farmer and the British farm-labourer, with their heritage of craftsmanship, are highly competent mechanics (on most unorthodox lines, it is true), and far more capable of mastering mechanical problems than the average factory hand.

There are, however, definite applications, such as pumping, where the advantages of entirely automatic control outweigh all other considerations. Cooking, heating and lighting are, perhaps, subjects which are best discussed separately as a problem of rural supply, irrespective of farming. It is worth placing on record, however, that the introduction of electricity to a farm for any of these purposes may prove a useful means of introducing larger equipment later on : the best salesman for electricity in agriculture is, paradoxically, the farmer's wife. In this respect it should be noted that it is a mistake, when making connection to a farm, not to do this on a scale which will permit of a considerably greater consumption at a later date than there is reason for anticipating at the time of installation.

In intensive farming, although the field is far more varied, there is a very much greater potential market for the consumption of electricity. In dairying, it is true, the small farm can be as conveniently supplied by a stationary engine as by a motor, although many a dairyman, who has had to start a refractory engine at 4 o'clock on a December morning, would be happy to make the change. Milking-machines, cooling plant, separators, bottle-filling and washing-machines, butter- and cheese-making machinery, are already run by power, and the deciding factor again is cost. There are possible uses of electricity for quick steam raising for sterilisation, perhaps the most important item of dairy routine ; and there is the further possibility of loads at night rates for water heating.

In stock farming and pig farming there are few openings for any form of power as things stand, except perhaps food preparation. In this connection special mention must be made of grinding equipment, and particularly disintegrators, where the electric motor, with its high possible shaft speeds, is clearly indicated.

Mention must be made at this point (although it is a problem which more properly belongs to the extensive farm) of the recent developments in this country of many drying processes, for grain which has been threshed in the field under the new methods, or for lucerne which is to be converted into meal, or for the recently discussed methods of producing concentrated foodstuffs from young grass. All equipment of this sort involves some form of fan, and for driving fans the electric motor has definite advantages over the internal combustion engine.

In poultry farming, which is rapidly extending in this country, there are very important openings which the industry cannot afford to neglect. Apart from the lighting of poultry houses which, in intensive systems of poultry keeping, workers at Harper Adams and elsewhere have proved to be a success, electricity, with its ease of control, has advantages for incubation on the larger scale, and the success of the mammoth hatcheries is largely dependent upon its use, though a stand-by plant in the case of interruption of supply still seems to be a frequent precaution. It is unfortunate that no statistics are available to show how seldom a serious interruption of supply occurs in this country during the hatching season. Electrical heating for raising chicks from day-old to six weeks or more is a coming field, either with radiant or low temperature heaters, both in battery and open type brooders, though oil and anthracite heating, with their obvious disadvantages, are still in more general use. On one farm in the south of England some 8000 chicks are brooded under electrical heaters with remarkable success, forming a load which the local Company supplies at ·71d. per unit, and this is by no means an isolated or even the largest installation of its kind.

The use of electricity for soil heating is still very largely in the experimental state, although there are a few commercial installations at work. There is still room for doubt as to whether electricity has any real advantage over other forms of heat on a commercial scale, except where power is available at very cheap rates.

The Institute has recently been working on the possibility of sterilising soil, which is necessary in many branches of nursery gardening, by electrical means, but it must be pointed out that there are many other applications for market gardening where there are encouraging indications that electricity might be of service. The cultivation of soil under glass in large houses, where a horse and plough are at present used, is an obvious field, and it might be suggested that power for this purpose could be conveniently taken from overhead wires in the same way as is done on a very much larger scale with the trolley bus. The question of small trailing cable cultivators for outside work has been under consideration, and if they can be produced at a reasonable cost they should have a good run. This is one of the internal combustion engine tractors' weaknesses: there is as yet no miniature tractor for all-round cultivation in general use in this country, although they are more common abroad under the stimulus of the special needs of the vineyard, but there are two or three British-made machines on the market, using internal combustion engines, which might at any moment become of economic importance.

Overhead spraying, or pressure irrigation, is a line which has been more developed on the Continent than in this country, and it has been claimed that this is a special application where electricity would be of very great value. This is a point which could be debated at some length. It is doubtful whether any special virtue attaches to electricity in this connection, and it is doubtful whether there have been any instances of its application in Europe on a strictly commercial basis. There are definite uses of what may be termed a luxury character for irrigation of this kind, but these, strictly speaking, fall outside the bounds of agriculture, and on the whole, taking into account the nature of the English climate, it is doubtful whether installations of this type could ever be expected to be an economic success. Spraying machinery is becoming yearly of greater importance in fruit farming, and there is room for all-round development of every type of spraying machine. The trailing cable would here prove a disadvantage to a commercial spraying machine, for the reason that the machine would have to be continually returning on its tracks. At the same time, the pressure line system, in which a more or less permanent installation of pipes is laid down throughout the orchard area, which has a considerable vogue in the United States, would appear to be an ideal application for electrified equipment in view of the extreme ease of control by automatic switching. At the moment, however, the high cost of an installation of this sort would seem definitely to rule it out of court in most of the fruit-growing areas.

To return to the question of pumping, which affects almost every farm and most dwelling-houses in the country, this country is behindhand in the introduction of the pressure tank system in place of the gravity tank. This system is not confined to the electrical pump, since it can be used quite successfully with the ordinary windmill driving equipment. The method is such a commonplace one in the States that outfits are catalogued by the large mail order houses which fill so large a proportion of the farmer's needs. There are definite advantages in the case of installation and reduction of unnecessary piping for domestic use, together with pressures of water which cannot be obtained from the usual tank in the roof. The small direct drive pump, of which there has been a gratifying increase in the last few years could, with a little ingenuity, be adapted for this purpose, but it would be preferable to use outfits specifically designed for the work.

There are several factors operating to make the farmer unwilling to embark on electrification beyond those already referred to, and it is not surprising that, of the 470,000 farms in England, only some 4000 are provided with electricity, either from the mains or public supplies. At the risk of vain repetition, it must be insisted that cost is the primary consideration. In the first place, the cost of obtaining connection to the supply is often considerable, and it is unfortunate that there is no means of cheapening the cost of connection when there is only a high tension line available. The farmer who is smarting under the inconvenience caused by steel pylons in his best fields, and what he considers the inadequate compensation paid for their presence, frequently feels this anomaly to an exasperating degree. It is useless to expect a farmer to pay £500 for connecting up when for the same sum he can buy two first-class tractors, and cases have occurred where a figure as high as £800 has been asked, although in most cases it is much lower. In the second place, the absence of a fixed rate per unit for the whole country is a serious deterrent. The National Grid should, eventually, on a logical basis, mean a national tariff, and it is to be hoped that the efforts which have been made to secure some measure of uniformity in this respect will be pressed as vigorously as possible. Motor fuel is uniform in price, although subject to unforeseen fluctuation and taxation. It is unfair that a farmer should be asked to take power at 3d. per unit (which, in practice, is very much less than is frequently demanded), when only a few miles away in another Supply Company's area he could obtain it at 1d. or ¾d. Not only is the price per unit variable, but, apart from the cost of connection, there is still a great need for a standardised form of agreement, in spite of the report of the Committee on Uniformity of Charges and Supply. Many forms of agreement in use depend on the floor area or the cubic content of the buildings to be connected, and the occupier of a farm which was built in the Middle Ages and had architectural accretions in every reign since, is penalised for the largeness of his forefathers' ideas, while the happy occupant of a cube of brickwork enjoys a cheaper rate. The consumption in each of these two instances may be precisely the same : in the one case the price per unit is such as to encourage the occupier to use more appliances and to consume more electricity, and in the other case is an inducement to use as little electricity as possible.

There are still too many instances of farmers being induced to sign contracts for more units than they can consume. It is almost impossible for a man to form a clear idea of his average requirements until he has had experience of his load over a reasonable period of time, and it will pay Supply Companies to allow as much latitude as possible in this respect.

It is perhaps questionable whether this country is suitable for rural electrification as a whole, although there are favoured districts, such as Aylesbury, Cheshire, Staffordshire, Shropshire, and South Wales, where the combined existence of a cheap rate and a supply engineer who has shown his capacity to face problems from the farmer's point of view has led to striking results, but this country differs from the rest of Europe in that it has had an internally peaceful existence for several centuries, and there has been no inducement to aggregate its farms, for mutual protection, into centres which can conveniently be dealt with by single transformers.

The electrification of a county like Lincolnshire, for instance, provides a problem in economic distribution which can barely be paralleled even in Holland.

The assumption has been made far too often that the spread of rural distribution lines will be followed by the rapid adoption of electricity for cooking and other domestic purposes. It is true that in the electrified districts there will be no competition from gas for cooking purposes, and the position will be distinctly different from that prevailing in the towns, but oil has already gone far to displace coal as a cooking fuel and is to-day almost as convenient to use as gas. In country districts, and in the Aylesbury area in particular, there seems to be a good market for the small electric oven, but cooking by electricity in the large house only begins to be attractive when the unit is below ¾d., and is usually out of the question at more than 1d. per unit : in any case it is probable that in many areas the load will be confined to a few hours at the week-end, and here again it must be remembered that there is already a demoralising fluctuation in the supply pressure on many rural areas during the peak-load hours (and particularly those hours at the week-end) against which, incidentally, the consumer has at present no easily obtainable redress.

It is, however, important from a national point of view that the capital already invested in the Grid should earn its interest, and the inevitable losses on some of the more ambitious rural electrification schemes should be minimised as far as possible. What is required at the moment is not so much research into new applications of electricity in agriculture as demonstration of the economic soundness of known applications, wherever possible. In addition to the existing demonstration areas in various parts of the country, more demonstration farms are needed, in which it can be shown, under reasonable tariff conditions, and with a reasonable capital cost for connection, that electrical power can compete with the internal combustion engine on a commercial basis in the small and medium-sized farms. The commercial basis must be stressed. Accurate and complete figures must be available which will enable inquirers to form estimates of their own requirements : what is more important is that the demonstration farms chosen must be normal farming units, not excessively capitalised, and run on strictly business lines by farmers known in their own districts to be sound men. It is useless to demonstrate the possible uses of electricity on the luxury type of farm where no expense has been spared, and equally useless to demonstrate on a farm which has completely equipped farm buildings and no farming outside to speak of.

To find suitable farms for demonstration will be a simple matter if the co-operation of the County Agricultural Organiser is sought in the first place. To induce the selected farms to electrify will be a less easy task, as they will in all probability already possess power units of their own which meet their existing requirements quite satisfactorily. The loan of equipment on a nominal rental or on an extended hire-purchase system is an obvious method, which has already been suggested. More use should be made by manufacturers of electrical equipment for agricultural purposes of the Royal Agricultural Society's Silver Medal tests for new machines, and of the Ministry of Agriculture's Testing Scheme for all machines, whether as a " public " or a " confidential " test.

It must be clearly stated once again that the main field of attack must be the small and medium-sized farm, and that the basis of attack must be actual working cost, with no insistence on convenience and other unseen assets. Convenience is a luxury which makes little appeal to the farmer until it has become a necessity. The history of civilisation is a record of luxuries which have become necessities, and in spite of the recent set-back, there are still grounds for accepting the American economic theory of producing prosperity by raising the standard of living. Colonel Crompton has suggested in his Rankin lecture that it will be sound policy for the Central Electricity Board to give financial help to the distributing companies during the years of development. There is every reason for supporting his contention that it would be " an absolutely sound proposition for one or more powerful companies, working in concert with the distributing agents, to give financial support to farmers who in these days are unable to provide the capital necessary for their installations."

SOME ECONOMIC ASPECTS OF THE SCOTTISH SHEEP INDUSTRY[1]

ALLAN H. H. FRASER, B.Sc., M.D.

Duthie Experimental Stock Farm, Rowett Institute.

IT has recently been suggested that the number of British breeds of sheep is too great, and that more systematic and uniform breeding practices would help the sale of British mutton in face of foreign competition. Whilst admitting the sale value of a more or less standard article, and although changes in markets have in the past resulted in radical changes in methods of husbandry, it must be emphasised that it is generally the sheep most suitable to a particular district which pay best in that district. Moreover, on many sheep arms the sale product is only indirectly related to the consuming market.

In Scotland breeding practice is not haphazard. The two basal breeds of Scotland are Blackface and Cheviot. From these two hill breeds crosses are produced to suit the upland and lowland grazings, and the great crossing sheep is the Border Leicester ram.

Crossed by the Border Leicester, the Blackface gives the Greyface lamb, more often simply termed a cross lamb. Much the greater proportion of these lambs, both ewe and wether, find their way to the butcher, and here there is a wastage, but also a reserve of valuable ewe stock. The Greyface, fattening readily at a light or medium weight, is popular in the London market. The ewe lamb grows into a first-class ewe suitable for second grade arable pasture. Crossed with a Down ram (and in Scotland those generally used are Oxford or Suffolk Downs), a lamb is obtained which fattens rapidly at 80-100 pounds live weight, and is an ideal milk lamb. Such Down cross lambs are very rarely bred from.

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In several counties, Angus, Kincardine, parts of Aberdeenshire and Perthshire, the production of Greyfaced lambs is the main sheep enterprise. To maintain the breeding flocks Blackfaced ewe lambs or gimmers are bought in from other districts.

The Cheviot, again crossed with the Border Leicester, gives the Scottish Half-bred. The Half-bred reaches a greater weight than the Greyface, and is more slow in maturing. It also requires more and better food. The ewe lamb grows to the Half-bred ewe, the predominant breed on the Border Lowlands and in the Lothians. Crossed with the Down breeds, the Half-bred gives a Down cross lamb, which is again seldom bred from. Until the year 1900 the Half-bred ewe was usually crossed with the Border Leicester, giving the Three-parts bred lamb. This lamb yielded an excessively fat carcass, unsuitable for the modern market, and is rarely seen to-day.

Scottish sheep thus flow in two great parallel streams, the sources of both streams lie in the hills, and the hill stocks are either Blackface or Cheviot. Caithness and Sutherland are Cheviot country. It is important to note that in this country the Cheviot has not been graded up from the Blackface, although it must have been crossed with the Merino. In Ross and Cromarty and in north Inverness there are stocks of both breeds. Then comes a belt of country, roughly from Speyside and Lochaber right down to the Lammermuirs, Pentlands and Lanarkshire Hills, a great home of the Blackface, which places a barrier between the north country Cheviots and those of the south. In the Border hills both breeds are again found, but here the Cheviot is of the south country type, which, while it may have been crossed with Merino and Ryeland, was certainly well mixed with Blackface, and that at no distant date.

Until the eighteenth century the Southern Uplands were stocked with the "short," Linton, heath, or forest breed, the forerunner of the modern Scottish Blackface. The sheep in the Northern Highlands, that is, beyond Stirling, were mainly the dun-faced, short-tailed breed kept as much for milk as for mutton or wool. The latter half of the eighteenth century saw two important innovations, the voluntary introduction of Cheviots to the southern uplands, and the enforced introduction of both Blackface and Cheviot to the Highlands. Cheviots were taken up because of their wool, which found a ready market in the booming woollen industry of Yorkshire, and after the Jacobite rising of 1745, men and cattle were driven from the Highland hills, to be replaced by sheep. The high prices for wool during the Napoleonic wars gave a tremendous impetus to sheep expansion, and particularly to that of the Cheviot.

About the year 1800 Merinos were fairly extensively tried, especially in Sutherland. They were given up because of their gregarious grazing habits, which evidently made them unsuitable for the patchy pasture of the Highland hills. They went about in a mob from one green strip to another, leaving the rough grazing untouched.

The struggle between Blackface and Cheviot was long and bitter. Until 1860 the Cheviot continually gained ground, usually by the repeated crossing of Blackface ewes by Cheviot tups. But in 1860 there was a severe storm, followed by a series of hard winters. Great losses occurred, and it was found that the Cheviot suffered very much more severely. Since that time the Blackface has re-established its ascendancy, except in Sutherland and Caithness where the Cheviot still reigns supreme.

In the Highlands the nineteenth century saw sheep farming at its height. Three types of stock were kept, ewe stocks on the better grazings, wether stocks on the highest or poorest, and running stocks on ground of intermediate character. In the running stocks the wether lambs were retained on the grazings until two, three or four years of age. In the ewe stocks the wether lambs were sold, to be bought mainly by the tenants of wether grazings. The Highlands thus produced a large number of mature wether sheep, which were sold to Southern graziers for fattening. In the last quarter of the nineteenth century a progressive fall in the price of wethers, combined with low values for wool, rendered this system unprofitable. Many of the wether grazings were turned into deer forests, and many of the running stocks converted into ewe stocks. It is certain that grazings are now under ewe stocks which fifty years ago would have been considered quite unsuitable for the purpose.

The present structure of the Scottish sheep industry (for it has a very definite structure) is the result of historical development. The lines of development were in the main determined by economic and political changes. It is obvious that unless there had been a reasonable prospect of considerable financial gain, Scotland would never have been so extensively colonised by sheep. It is further obvious that the rapid and extensive development of Highland sheep-farming could not have taken place without the previous destruction of the clan system.

Of the two basal breeds it may be said that the Blackface owes its present supremacy to its breed characteristics, which make it especially suitable for high grazing, poor keep, and a severe climate. Nevertheless it must be recognised that the organised system of sheep farming formerly prevalent in the Highlands has been extensively modified in recent years, in that the sheep are sold at a much younger age and the proportion of breeding ewes increased. It is also true to say that without the almost universal custom of wintering the ewe hoggs on lowland arable pasture, the breed characteristics of size and early maturity could not be maintained. Should wintering become more expensive or less readily procured, it is certain that many Blackface stocks on the higher and poorer grazing would degenerate in size, prolificacy, and early maturity to a much smaller and goat-like sheep in biological harmony with its particular grazing area.

The Cheviot owes much of its prevalence to the high price obtainable for its wool when foreign competition has been restricted by wars, and to the pioneer zeal of Sir John Sinclair and the Wool Society which he founded. There is no doubt that in the early days of sheep colonisation of the Highlands, the influence of Sinclair was thrown in favour of the finer wooled sheep, and that the predominance of the Cheviot north of Inverness-shire to-day owes much to the enthusiasm of that one man. Although his schemes for the acclimatisation of the Merino failed, the results of his introduction of the Cheviot were successful, since he brought together a breed of sheep and a country which it suited.

The period in which Sinclair worked was one of unexampled prosperity to the trade. Fresh grazing tracts at low rentals became available at a time when the English textile industry and industrial population were expanding and increasing most rapidly. Experiment and enterprise were justified, since sheep-farmers were working in a period of increasing grazing area, increasing markets, and rising prices. Without an expanding and profitable market to absorb its products, the Scottish sheep industry as we know it to-day could never have been developed.

The position of the flock-master to-day is an entirely different one. He is faced with a decreasing grazing area, since sporting rights have lately been more profitable than grazing rentals. He is faced with a decreasing market for his goods, since industrial prosperity has declined and imported mutton is claiming an ever-increasing share of the home market. Apart from the ten years or so of prosperity due to the great war and the resulting shrinkage of stocks, he has had to face a progressive fall in the relative value of his product. This fall is greater than might at first appear, since the more cheaply produced mature mutton is scarcely saleable at all. Under the present depressed circumstances, therefore, any radical alteration in the Scottish system of sheep-rearing cannot be contemplated, no matter how apparently beneficial such a change may be. There is not the capital available in the industry to carry out sweeping improvements, nor is there a sufficient promise of profit to induce the flow of outside capital to finance such improvements.

Nevertheless within its own structure the present Scottish system is wonderfully adaptable. In times of prosperity in the industry sheep encroach on the lowlands. Arable farmers lengthen their grass shift or lay down permanent grass. They keep flying flocks of cast hill ewes, and breed lambs. Ewes which ought to go to the butcher are kept for breeding. There is a good demand from small arable farmers for broken-mouthed ewes, and cast hill ewes are in demand. The effect on the hill farmer is that there is a better demand for his cast ewes which rise in price, and scarcity and dearness of wintering, since much of the usual wintering grounds is occupied by flying flocks of ewes. By such a simple extension of the life of ewes and of temporary leys the Scottish output of mutton can at any time be considerably increased.

In times of depression and falling prices a large number of arable farmers go out of sheep altogether, thus throwing increased numbers of sheep on the market at a time when demand is slack. The result is apt to be a disastrous slump in sheep values. While the hill farmer suffers from a fall in value of his stock, he benefits by a reduction in cost of his wintering.

The balance between the different crosses of either of the basal breeds is also regulated by economic factors. For example, within living memory many pure Blackface stocks on the better grazings have been converted to crossing stocks, producing Greyface lambs. As has been shown, such stocks depend upon the annual introduction of bought-in Blackface gimmers. The ability to realise a profit on such stocks depends, among other things, upon the price at which Blackface gimmers can be bought. If too many breeders crossed their ewes, the price of Blackface gimmers would rise sufficiently to induce a return to a system of pure breeding. The price of the Blackface gimmer and of the Blackface cast ewe therefore regulates the relative proportions of blackfaced and greyfaced lambs annually produced. The same relationship holds between the Cheviot and the half-bred stocks.

A great deal has been written about producing sheep suitable for the requirements of the mutton trade. It has been suggested that the number of breeds might be advantageously reduced. Unfortunately market demands are largely a question of fashion, which changes more rapidly than it is possible to produce new breeds of sheep. Moreover, market requirements are not uniform; for example, the types of sheep required for London and Newcastle are entirely different. In Scotland this difficulty is largely overcome by retaining the two foundation breeds and varying the final product by changing the type of ram used for crossing. For example, the half-bred ewe can be crossed with anything from the Leicester to the Southdown, depending upon the market tendencies, which are immediately reflected in variations in the relative price. Not only Scotland, but the world, must be grateful to England for retaining such a variety of pure breeds for crossing purposes. It would be a thousand pities if enthusiasm for market uniformity led to a reduction in their number, since they are irreplaceable, and since any one of them may be found to be the ideal crossing sheep for some future market requirement which cannot well be predicted.

It is often forgotten that Scotland is a meat and livestock exporting country. Thousands of store sheep, and of fat sheep dead or alive, cross the border each year, and the prices prevailing at the London dead meat market are reflected throughout the Scottish sheep trade, not only in the price of fat lambs produced in the lowlands, but of lean store lambs and cast ewes from the hills. A slump in Smithfield market may mean bankruptcy to a shieling in Strathmore. Under modern conditions the provincial centres are extraordinarily sensitive to London prices, and dealers attending quite remote sale centres are fully informed of prices current that morning in London.

Every autumn in Scotland there is a great sheep migration, reflected in the series of autumn sheep sales in August, September, and October. The drift of the migration is from North to South, and from the hills to the low ground. Aberdeenshire graziers buy extensively in Sutherland, Border breeders in Aberdeen, and Englishmen at the Border sales. Hill sheep come down to the lowlands, the wether lambs to kill or to fatten, ewe lambs to winter or to gimmer, cast ewes to feed or to breed. Hill stocks are thus reduced to a minimum during the critical winter and spring months. In general it is uneconomic to bring feeding sheep from South to North since they have to be sent South again when fat, and carriage is a double charge to the feeder. Breeding sheep are, however, sometimes brought North—for example, Blackface ewe lambs are bought extensively in Lanark to be gimmered in Aberdeenshire, and then sold to recruit the crossing Blackface stocks of the neighbouring districts. In these extensive sheep movements the industry entails very heavy transport charges. Since these charges are smaller per head where large numbers of sheep are sent together under one name, there is evidently scope for simple co-operative action by sheep farmers. Such co-operation is already practised in islands such as Arran, emphasising the general fact that a sea passage for produce is the strongest incentive to co-operation among producers.

It is unfortunate that there is an annual seasonal glut of Scotch mutton. In the autumn not only the bulk of the lowland lambs are killed, but the forward lambs from the hills also find their way to the butcher. Many lots of well-conditioned stores are also bought by dealers direct for slaughter. This seasonal glut is unfortunate for the producer, since most farmers have to realise their surplus sheep at a time when supplies are abundant and prices naturally low. Repeated suggestions have been made that lambing might be spread over the year, and more lambs sold at seasons when prices are relatively high. Arable farmers are already adopting this plan in that they lamb earlier as a rule, and sell more fat lambs during the summer months. It is obvious that such a system cannot be adopted on the hill, and the chief advantage of early lambing and forced production on arable sheep farms is the avoidance of competition with the forward lambs from the hills. Apart from this it is quite clear that the better price received for winter lambs is a result of their scarcity, and that if winter lamb production became in anywise general, the price advantage would inevitably disappear. A practice profitable for the few cannot be equally profitable for the many, and winter costs of production in Scotland must always be higher than those of the natural growing season.

The seasonal glut in Scotch mutton appears to be unavoidable. A farmer is seldom in a position to hold up his supplies in the hopes of a more favourable market, and usually sells according to the times of special sales arranged by the auction markets, or according to food supplies on the farm or cash supplies in the bank. The rapid strides that are being made in low temperature research, while introducing a further menace to the home producer, also offer a hope that it may become possible to freeze the summer surplus of home produced supplies, to be sold during the winter without any deterioration due to cold storage.

In considering the future of the Scottish sheep industry it must be at once admitted that its earlier prosperity is unlikely to be regained. The fortunes made out of the exploitation of hill grazings cannot be repeated. The ground is to a large extent overgrown with bracken, depleted of minerals, fouled with parasites and the germs of disease. While modern knowledge offers remedies for some of these evils, it takes money to apply them, and in the earlier days such expenditure was not required. With a rise in the margin of sheep profits many improvements would be undertaken; without such a rise improvements cannot be embarked on by the farmers themselves.

The system of acclimatisation value current in many hill districts of Scotland is much criticised and sometimes abused, yet there is no more potent force is stabilising the industry. Since sheep on their native hill are worth more than in the auction market, there is an incentive to retain sheep on their grazings which might otherwise be dispersed in times of depression, thus further overloading the market with unwanted stock. This acclimatisation value is put by experienced flock-masters at a very high figure, since the death-rate among sheep recently introduced is often excessively high, and because a sheep stock takes several years to heft properly and to exploit a grazing to the full. At the same time one suspects that acclimatisation value is sometimes so high as to cripple a sheep-farming enterprise by over-capitalisation at its inception.

There do not appear to be any insuperable difficulties in increasing Scottish mutton production, provided a sufficiently profitable outlet can be found for it. The recent advances in pasture management and seeding have already increased the stock-carrying capacity of many arable farms beyond the farmers' financial capacity to stock them. Close grazing of sheep demands a rigorous control of intestinal parasites, a scientific problem which is rapidly yielding to research. Limited artificial feeding on most arable farms will allow even twin lambs to be sold fat before autumn. The annual crop of lambs could be greatly increased by more careful selection for prolificacy in ewes and rams.

The foundation hill stocks are a more serious problem since they form the basis of the whole industry, and because the stock-carrying capacity of many hill grazings is actually decreasing. The obvious remedies, such as the renewal of drains, the cutting of bracken, an increase in the number of cattle, are impracticable only because of a lack of capital to carry them out, and the lack of confidence of any capital expended yielding a sufficient return.

In regard to hill pasture improvement it is possible that too little attention has been devoted to the many valuable plants which occur naturally on hill grazings, particularly moisture-loving plants such as the draw-moss, the sedges, the rushes, which provide valuable food in spring. It is possible that too much energy has been applied in attempts to model hill pasture in the likeness of a lowland meadow, and that more could be done by studying the conditions under which the most valuable hill plants grow, and by attempting to alter conditions so that they may grow on grazings where they are absent.

The control of disease, by decreasing wastage, is a hopeful line in increasing the productivity of hill stocks, and is one which is making rapid strides at the present time. Unfortunately application of veterinary preventive medicine is sporadic and localised, and there is a definite danger of calamity in rearing disease-free but susceptible stocks when exposed to risks of reinfection from neighbouring stocks where disease has not been eradicated.

It seems clear that mineral deficiency is a cause of losses and low production on many grazings on certain geological formations, and the direct supply of the deficient minerals to the grazing sheep is of undoubted advantage to production, and affords hopes of economic practicability.

While various readily available means of increasing production have been briefly outlined, it is doubtful whether under present conditions increased production would benefit the sheep-producing community as a whole. Of course, as always, a skilful pioneer would reap a personal benefit, but a rapid increase of production in the face of falling prices and a contracting market would spell further disaster.

The paramount need of the Scottish sheep industry to-day is a profitable outlet for the mutton and the wool that it produces. Modern advertising can sell anything from medicines to correspondence courses: can it not be used to sell good food? There is a vogue for small immature joints. Can that fashion not be altered so that the wether trade may revive? Since the tailor has a say in controlling fashions in clothes, so has the butcher in controlling fashions in meat. Lamb can be sold without being hung, resulting in a saving of storage space, a closer adaptation to current markets, and a quicker overturn to the butcher. Wether mutton cannot offer these advantages to the retailer, but to the consumer has mutton fed on the clean heather of Scottish hill-sides no romantic appeal? There is no doubt that with better sales organisation, national grading and marking, and above all, by clever advertising, more Scottish mutton could be sold and at a better price. Efficient marketing organisation is the main hope for increased prosperity in the Scottish industry of to-day and to-morrow. Given better prices and an expanding market production will automatically increase. Practical ingenuity and agricultural science can be trusted to deal adequately with such difficulties in production as may arise.

PEAT MOSSES—II

THE DRAINING OF PEAT LAND

IAN M. ROBERTSON, B.Sc., Ph.D.

Macaulay Institute for Soil Research

THE growth of peat-forming plants, and hence the formation of peat, takes place on land surfaces where an abundance of water exists. Peat itself is sponge-like in character, and after heavy rain can hold as much as 95 per cent. of water, so that peat lands have in common the presence of excess moisture. This factor renders them quite unsuitable as a medium for the growth of cultivated plants, and the first essential in the reclamation of peat land is the establishment of an efficient drainage system. Once the excess water is removed, air penetrates the upper layers of the peat and assists in the soil-forming processes : bacterial activity is stimulated, bringing about increased humification and nitrification, and the commoner plant poisons such as sulphides of hydrogen and iron, which are often found in undrained peat land, are rendered harmless by oxidation. At the same time it is necessary to avoid over-drainage in peat soils, as this has been found to produce as harmful an effect on crops as the presence of too much water. The danger of over-draining does not apply so much to districts where the precipitation is very high, nor to districts where the precipitation is evenly distributed throughout the year, but rather to regions where periods of insufficient rainfall or drought are experienced.

The Regulation of the Soil-Water Level and its Influence on the Growth of Plants.—The amount of water which a soil can hold may be considered to exist in two fractions. One of these is combined in the soil itself by forces within the soil particles and cannot be used by the plant as part of its water supply, while the other is held mechanically and is available to the plant. The plant nutrients present in the soil dissolve in this available water supply, forming a dilute solution which is absorbed by the plant roots during the growing season. The dissolved materials are removed from solution and the water is given off from the leaves, stems, etc., during transpiration. It follows that the amount of available water should be sufficient to supply the needs of the particular crop grown, otherwise symptoms of drought and starvation will appear. From the results obtained on a soil which had been manured to produce the highest possible yields, and which had a sufficiency of water, it has been calculated that the production of one pound of hay (dry matter), one pound oats (dry matter in corn and straw), and one pound potato tubers, is associated with a water consumption of 800 lb., 500 lb., and 160 lb. respectively. Take, for example, average crops of hay and potatoes as 2 tons and 6 tons per acre respectively. These figures represent a water consumption during the growing season equivalent to 16 in. and 9½ in. of rainfall.

The amount of available water in a soil is given by the difference between the total amount of water present and the amount combined in the soil. Peat soils have a high water-holding capacity and may contain as much as 95 per cent. of water, but at the same time, on account of their colloidal nature, a very large part of the total water is present in a combined or " unavailable " form. Numerous experiments have shown that once the water content falls below about 60 per cent. symptoms of crop failure appear, and it would seem that the optimum water content for the growth of agricultural plants on a peat soil is somewhere in the neighbourhood of 85 per cent. It may be mentioned here that with very sandy soils symptoms of crop failure do not appear until the water content falls to about 5 per cent.

When draining moorland a further point of great importance must not be neglected. Should the area be overdrained, the humus colloids give up part of the combined water in warm dry weather, and the surface of the soil becomes light and granular, and is then blown about by the wind. Even after very heavy rain much of this material is not re-wetted.

In any control of the soil-water the growth and rest periods of the plant should be differentiated. During the growth period of most of our agricultural crops—April to September—large amounts of water are removed from the soil, and accordingly the level of the ground-water should be raised to supply the needs of the crop. In the autumn and winter months, however, when plant growth is at a minimum, it is advisable to lower the water level as far as possible and allow free access of air. In addition, a low water level in early spring ensures a quicker warming of the soil and provides a better medium for the young plants. Experiments carried out at Landsberg to compare yields of clover-hay grown on a soil where the ground-water was (*a*) maintained at a constant level during summer and winter ; and (*b*) raised in summer and lowered in winter, show an increase of 11·5 per cent. of the latter over the former.

The actual level at which the ground-water should be maintained in order to obtain the optimum moisture conditions for plant growth depends mainly on the rainfall of the district under consideration, but also to some extent on the crop to be grown. Where the rainfall figures are very high, as for example in Stornoway where the average is nearly 50 in., the vital question is not the conservation of moisture but the removal of surplus water which, if not immediately carried off, will cause flooding. In districts with a rainfall of around 28 to 30 in., as for example in north-east Aberdeenshire, a suitable regulation of the ground-water level should produce increased crop yields. On the Continent and in Scandinavia it is recommended that during the growth period the level of the ground-water in regions having an annual rainfall of 25 to 32 in. should be maintained at from 1 ft. 3 in. to 1 ft. 6 in. for hay, 1 ft. 9 in. to 2 ft. 3 in. for pasture land, and 2 ft. 3 in. to 2 ft. 8 in. for cropped land. The drains themselves are set 3 ft. to 4 ft. deep, and the high-water level in the spring and summer months is maintained by holding up the water within the area by means of sluices.

The Main Ditch.—Before a complicated system is laid down it is necessary to construct a main ditch or leader, which should be of such a nature that the water discharging into it from the subsidiary drains is efficiently carried off. Small streams are to be found running through most moorland areas, and it is usually possible to construct an excellent main ditch by enlarging and straightening the existing water course. The dimensions of the leader depend upon the particular needs of the area to be drained. Where large stretches of flat land are concerned, the lengths and fall of the side drains have to be considered in determining the depth of the leader. Again, in shallow peat of 3½ to 4 ft. overlying a porous mineral subsoil, it is often bad policy to cut the main ditch too deep into the subsoil on account of the risk of overdraining. Where the mineral subsoil is impermeable in character, and in the case of deep peat, such a difficulty does not occur, and a channel of about 6 ft. in depth, following as far as possible the natural water course, should be aimed at. The sides should be sloped to the water level, the angle of the slope being less in soft than in firm peat. The breadth of the water channel is, of course, determined by the volume of water which is to be carried.

Subsidiary Drains.—Once a suitable main ditch has been constructed, the digging of the side drains can be proceeded with. In this connection it is essential that an examination of the moorland area and its surroundings be made, and some idea obtained of the depth and character of the peat, the nature and permeability of the underlying mineral soil, and, what is most important, the flow of the ground-water within the moor and from the surrounding mineral soil.

In deep moorland the distance between the drains depends on the composition of the upper layers of peat. An undecomposed moss peat, for example, has a much higher water-holding capacity than a well decomposed grass peat, so that in the former type drains should be slightly deeper and closer than in the latter type. In shallow moorland of 2½ to 3½ ft. in depth, the drains should not penetrate far into the mineral soil, and may in some cases be spaced fairly far apart, especially where the subsoil is permeable.

An investigation of the moisture conditions prevailing in a moorland area and in the surrounding mineral soil will bring to light the factors causing the formation of peat. If no water flows through or over the surrounding country on to the area, the accumulation of peat is to be accounted for by the rain falling directly on the area and being held up within it. Under such conditions over-drainage must be carefully avoided, since a water-supply coming entirely from the rainfall is not always in itself sufficient to support average crops (see page 161). When, in addition to rainfall, surface and ground-water from the surrounding land flow over an area, the peat formed is usually exceedingly soft and deep. This is quite a common occurrence where water flowing from hillsides collects in a valley floor, causing bogging and ultimately the appearance of a peat moss. In such cases a trap ditch should be cut round the border of the moss and should penetrate into the subsoil so as to catch both surface and ground-water flowing into the area. The main ditch should follow, as far as possible, the course of the natural drainage channel running out of the valley. If the trap ditch is omitted, an unsatisfactory and uneven drainage results, and as a rule much more draining is required to remove the surplus water.

After a drainage system has been in action for some time and part of the surplus water has been removed from a moorland area, a decided fall in the level of the surface is observed, and, as the moor becomes dried and soil-forming processes are encouraged, the shrinkage becomes more and more evident. The amount of shrinkage following drainage is very difficult to forecast, as it depends on so many factors. Of these the depth of the peat, its chemical, physical and botanical composition, the depth and type of the drainage system employed, and the rate of decomposition after draining are the most important. Thus, for example, a deep layer of loose undecomposed moss peat with its high water-holding capacity shrinks much more than a compact, well-decomposed brushwood or sedge peat. In a large stretch of moorland it is often found that a uniform layer of well-decomposed peat is interrupted by a deep pocket of loose, spongy, undecomposed material representing an overgrown lochan or hollow in the moor, where the accumulation of peat has been extraordinarily rapid. After draining, an unequal shrinkage takes place, and the lochan again becomes apparent as a slight hollow.

It is obvious that the amount of shrinkage will be greatest in the upper layers of peat, and will fall off with depth towards the bottom of the drain. Shrinkage, however, does not cease at the maximum depth of the drainage system, but extends to some distance below it, so that the bottom of a drain passing through different types of peat may also become irregular in the same way as the surface of the moor. After drainage has proceeded for some time it is often found that shrinkage has been so great that a deepening of the drains is required to remove sufficient ground-water. With open drains this is easily accomplished, but where covered drains have been installed the deepening will entail a considerable outlay. Hence, whenever covered drains are contemplated, every possible precaution should be taken before the drains are laid so that deepening will not be necessary. In very soft, wet peat it is often impossible to cut a ditch of more than a few inches in depth without a collapse of the sides, and in such cases it is advisable to proceed very slowly, taking out a few inches at a time, and allowing the sides to harden sufficiently before the deepening process is continued.

The subsidiary drains can be divided into two classes: (1) open drains, and (2) covered drains.

(1) *Open Drains.*—The following dimensions have been found most suitable for open drains in deep peat in regions with an annual rainfall of about 30 to 35 in.: breadth 1 ft. 6 in., depth 2 ft. 9 in., fall 0·2 per cent. (1 in 500), distance between drains 20 to 25 yards. The sides of the drains in a peat moss have been found to stand best when cut perpendicularly.

Before going on to describe the covered drains, a short summary of the advantages and disadvantages of the open drainage system may be given. Open drains can readily be deepened if required, and conversely, can be allowed to fill up if already too deep; if a portion of a drain becomes choked the obstruction can be located and removed with a minimum of trouble; on account of their large cross section open drains require less fall than closed drains, and, in addition, can conduct more water in a given time.

There is, however, a larger number of disadvantages. Modern farm machinery is exceedingly difficult to manipulate in the limited space provided by an open drainage system; the available surface of the drained land is considerably reduced on account of the actual breadth of the drains, and because it is impossible to utilise the land immediately alongside the drain without damaging the sides; these narrow strips of land and the sides of the drains become weed infested and require constant attention; the cost of cleaning open drains may be considerable, especially if stock is allowed on the area.

(2) *Covered Drains.*—The disadvantages of open drains given in the preceding paragraph are eliminated by the use of closed drains, which, in addition, possess several distinct advantages of their own. For example, they will run freely all the year round, and even in

severe frost the depth of the drains guards against the possibility of freezing. In exceptional cases the outlet does become frozen, but this happens very occasionally. The result of the even flow during winter is to keep the ground level as low as possible, so that the land is dry and warm in spring and makes an exceedingly good medium for plant growth. Open drains, on the other hand, freeze up very readily, and, with severe frost, a layer of ice is formed on the sides and penetrates some considerable distance into the peat, forming a most effective barrier to the outflow of drainage water. Even after a rise in temperature takes place the ice layer can persist for weeks, holding back every drop of water and leaving a wet, cold soil in the spring. Covered drains also give a better distribution of surface moisture, since open drains with a large exposed surface permit of greater evaporation, and have a correspondingly drier strip near the edge of the trench. Finally, examination of the soil air from areas drained with closed and open drains shows a higher oxygen content in the former, indicating a better penetration of air into the soil.

The advantages of covered drains are so numerous that it is now the general practice on the Continent and in Scandinavia to instal this system almost exclusively, and since the end of last century thousands of acres of peat land have been drained with faggot, tile, or box drains. Indeed, the reclamation and cultivation of much of the land would have been impossible had not this type of drainage enabled large areas of unbroken land to be cultivated with the aid of modern machinery.

Several details must be considered before the laying of a closed drain is attempted. In the first place it is necessary to allow for the shrinkage which occurs in the upper peat layers after draining, and this can be done either by leaving the drains open until most of the shrinkage has taken place, and then cleaning them out to the proper depth before laying the drain, or, if the drain must be completed immediately, by laying it slightly deeper than is required so that the correct level will be assumed after shrinkage has taken place. Again, where tile drains are to be laid, it is advisable to guard against the possibility of displacement caused by sinking of the peat or by the passage of machinery over the completed drain. This is accomplished by laying the tiles in a bed of heather or similar material.

The draining of large areas is usually carried out by running the parallel lines of closed drains into a series of collecting drains 3 ft. wide and about 4½ ft. deep, which empty directly into the main ditch at intervals of 250 to 300 yards (Fig. 1). The length of the collecting drains is determined by the fall which can be obtained (0·15 to 0·20 per cent.), but usually a distance of some hundreds of yards is possible, giving a field between two collecting drains of 10 or more acres. The collecting drains are, as a rule, left open, but if very large fields are required they may also be covered.

In order to avoid breaking the sides of the collecting drains, the trenches made for box or tile drains should not be dug directly into the former, but should be stopped 2 or 3 ft. from it, leaving a bank of peat separating the drains. When the drains are being laid, a hole, into which the end of the box or pipe is introduced, is made through the bank into the collecting drain (Fig. 2.)

The laying of side drains should be commenced at the bottom end—that is, at the end running into the collecting ditch, and proceed backwards, allowing for the "fall" which is to be given. One reason for this is that, in land where the open drains have been allowed to run for some time, the peat near the collecting drains (at which part both these and the side drains exert an influence) will have shrunk much more than that at the head of the side drains. The peat at the latter part, however, continues to sink after the drains have been laid, until finally the whole surface becomes uniform. Side drains set off from the collecting drain will then be in their proper position, even although the upper end may have been deeper in the peat than the lower when first the drain was made. Had the drain been laid with respect to the land surface, the upper end, on account of shrinkage, would soon have been very near the surface, while the lower end, in a peat which has already shrunk to about its full extent, remained at the correct depth.

The most suitable dimensions for the drains in a covered system are as follows: average depth 4 ft. (if open drains have been allowed to run for some time), breadth 2 ft. 6 in. at the surface sloping to 1 ft. 3 in. at the bottom, fall 0·25 per cent. (1 in 400), length 125 to 150 yards, and distance between the drains 20 to 22 yards.

Types of Covered Drains.—Many types of closed drains have been employed in the draining of peat land, and care should be given to the choice of a suitable type and to the details of construction, if the draining is to be carried out in an efficient and economic manner. In some districts, as for example in the Hebrides, wood is very expensive and in consequence some of the more costly wooden drains are out of the question, but where "slabs" can be obtained at a reasonable cost from a sawmill where logs are being dressed, a very efficient box drainage can be constructed. Soft, well decomposed peat often presents difficulties where box or tile drains are installed, and unless precautions are taken the drains soon become choked with finely divided peat sludge. The difficulty can be overcome in most cases by laying the drains in a bed of heather, or by employing faggot drains laid in heather or turves.

Formerly it was the practice to use stone drains where the sole of the trench could be cut down to the mineral soil, and in many parts of Scotland the old stone drains laid down in the early days of draining are still in use. Nowadays, however, their construction is uneconomical.

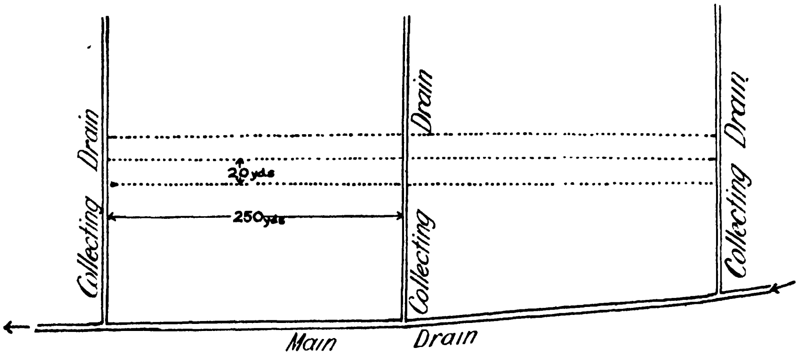
Collecting Drain
Collecting Drain
Collecting Drain
20 yds
250 yds
Main Drain

FIG. 1

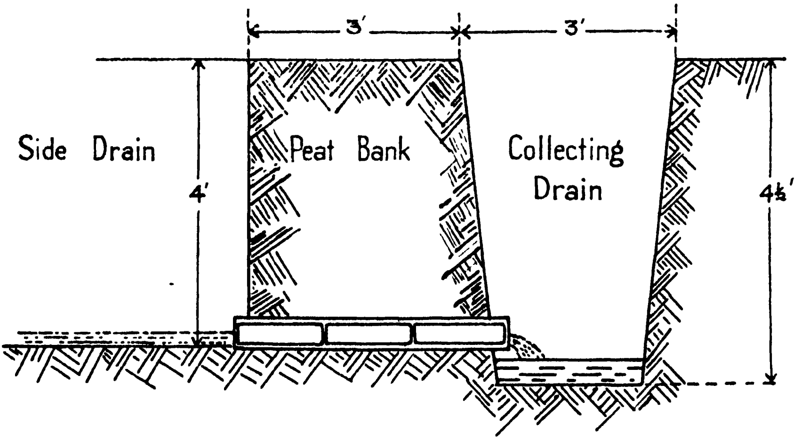
3'
3'
Side Drain
4'
Peat Bank
Collecting Drain
4½'

FIG. 2

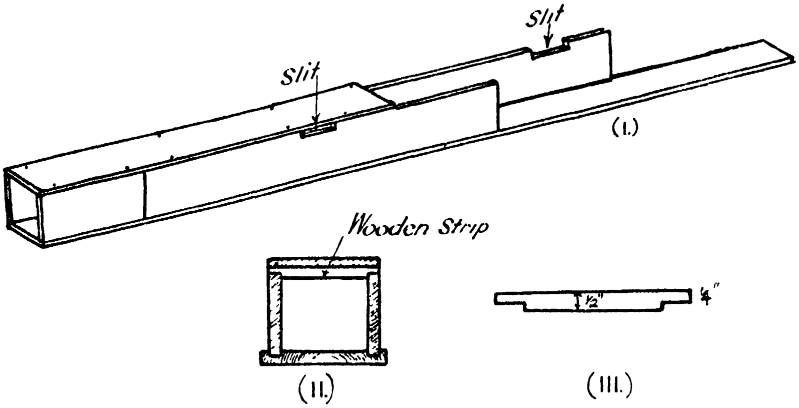
Slit
Slit
(I.)
Wooden Strip
½"
¼"
(II.)
(III.)

FIG. 3

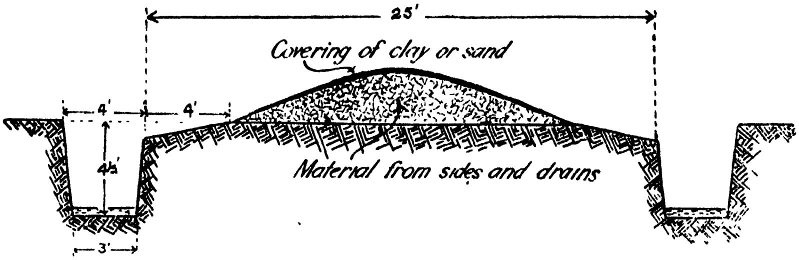
25'
Covering of clay or sand
4'
4'
4½'
Material from sides and drains
3'

FIG. 4

The most important types of drains in use are :

(*a*) Turf drains.
(*b*) Faggot and Pole drains.
(*c*) Box drains.
(*d*) Tile drains.

(a) *Turf Drains.*—The simplest form consists of an approximately square channel of 4 in. internal breadth built of dry peats or turves. Another form, useful where the sole of the trench is firm, is constructed by removing a small square furrow, 4 in. broad, along the middle of the trench and covering it with large dry peats or turves. Turves should be placed with the upper side facing downwards. Turf drains were used in the earliest attempts at moorland draining, and were described by Anderson in 1794, but to-day they are suitable only for small areas which are not to be worked by heavy machinery. Rats, etc., must be excluded, as they soon destroy the channel.

(b) *Faggot and Pole Drains.*—Faggot or fascine drains, although not commonly used in this country, are extremely useful, especially in soft sludgy peat. Their construction is simple, and can be carried out efficiently by unskilled labour. Bundles of faggots, free from twigs, are bound tightly together with wire so as to form an extended roll 10 to 12 in. in diameter, and as long as possible. The sticks need not be of the same length, and should overlap from one bundle to the next so that when bound together a rigid structure the length of the drain trench results. Heather and turves should be used to bed these drains, and a covering of 6 in. of the same material should also be used. The fall should be slightly more than the normal for closed drains. Where proper precautions have been taken in the construction of faggot drains, they have been known to remain in good working order and in excellent condition for more than thirty years.

Pole drains are similar to faggot drains in that straight stems are bound together to form a continuous unit 6 to 9 in. in diameter running the whole length of the drain. A bedding and covering of heather should be introduced as with the faggot drains. This is a most expensive method unless wood is to be had at a low cost.

(c) *Box Drains.*—The simplest form of box drain is constructed from "backs" or "slabs" obtained from the dressing of logs. The sides should be strips 3 to 4 in. broad to which "backs" are nailed to form the top and bottom. The top should not fit tightly over the sides, but should leave sufficient space for percolation of the groundwater. A more elaborate form is built of planks ½ to ¾ in. thick, 4 in. broad, and any convenient length nailed together as in Fig. 3 (i), so that one continuous box the length of the drain is obtained. It must be emphasised that continuity is essential in order to obtain rigidity and prevent displacement. Slits are provided at 2 ft. intervals along the top of the sides to allow free percolation of the drainage water. In acid peat, however, metal nails are quickly attacked, and after some time the boxes collapse. A modification has been introduced to obviate this difficulty (Fig. 3, ii). The sides are slightly countersunk into the bottom, while, instead of slits, the top is raised from the sides by nailing it over narrow strips of wood one inch broad (Fig. 3, iii), which serve the double purpose of allowing free entrance of drainage water, and also preventing the sides from falling in under the lateral pressure once the nails have been destroyed. The nailing of such drain boxes is only required to prevent their coming to pieces when they are being laid. Once the trench is filled in, the pressure of the peat on the box is sufficient to ensure a perfect drain, even without nails. To prevent the entrance of finely divided peat heather or turves should again be made use of as packing.

Box drains of triangular cross section may also be used, but collapse more readily under pressure than the square type.

(d) *Tile Drains.*—Unlike the forms already described, tile drains cannot be connected together to form a continuous unit, and in order to prevent displacement of the pipes, various procedures have been adopted to obtain a firm bed for the drain. Boards, for instance, are often used, but bedding in heather has been found much more satisfactory, and is also cheaper.

The trench is cleaned out and filled with 6 to 8 in. of heather, which is packed down evenly from the surface with a rammer. Ten or twelve pipes (2 in. internal diameter) are then slipped on to a wooden pole, or better, an iron tube of convenient length (gas tubing serves admirably), and lowered on to the bed of heather with two long-shafted hooks. A good covering of heather is placed on top, after which the trench is partly filled in and tramped hard. The iron tube is now removed from the pipes and the process repeated. When laying the second and successive sets of pipes, the free end of the tube should be placed within the last pipe of the set previously laid. During the procedure it is only necessary to half fill the trench ; the remainder can be filled and tramped when convenient. The heather not only forms a perfect bedding for the pipes but also acts as a filter to keep back peat sludge. When heather is unobtainable, straw, reeds, or fine brushwood (*e.g.* fir branches) make good substitutes.

It has already been pointed out that the laying of a drain should be commenced at the lower end and proceed backwards. Unless this is done when laying tile drains it is impossible to withdraw the iron tube. In addition, the water pressed from the sides of the trench during the work is carried off by the drain, leaving a dry sole in front of the workmen. If the drain is laid from the top end the water runs down the trench, leaving a muddy sole on which to lay the pipes. As an additional precaution against displacement, the bottom two or three pipes which pass through the bank of peat into the collecting drain (see Fig. 2) may be placed in a wooden box or set on a plank. Tile drains laid as described have been found to remain in perfect alignment after being over thirty years in land worked with heavy machinery.

The Excavation of Drain Trenches by Machinery.—Until recently the excavation of trenches in soft peat land could only be undertaken by hand, but now draining machines pulled by a suitable caterpillar tractor will work efficiently on the softest of moor surfaces. This is a very valuable achievement, as it enables both shallow sheep drains and deep moorland drains to be constructed at very low cost. Two draining machines, one devised by Messrs W. Henderson and Sons, Catrine, Ayrshire,[1] and the other by Mr A. B. M'Farlane, Glasgow,[2] have been found to do good work on peat land. The first mentioned can cut deep drains as well as sheep drains, while Mr M'Farlane's machine is intended to make trenches up to 15 in. in depth. The drain length cut per hour depends on the condition of the land surface, but is approximately 1500 yards. The cost is a fraction of a penny per yard.

Conservation of Moisture in Peat Land.—It has been pointed out that carefully controlled moisture conditions produce the best results, and that in summer the water required by the growing crops, especially hay and pasture, is not always supplied by the rainfall. Conservation of water within a moorland area is best brought about by blocking the ends of the collecting drains with a sluice and holding back the water in the side drains. In acid moss peat, the roots of agricultural plants penetrate only where the harmful influence of the naturally occurring acid has been neutralised by the addition of lime, that is, to the depth of cultivation. In order that the upper layer should receive a plentiful supply of water the capillaries conducting it from below should be assisted in their action by rolling the land surface in spring with a heavy roller. This compresses the peat and increases the amount of water in the upper layers. The addition of sand to the surface of peat land retards evaporation and increases the water-content of the upper layers, and is therefore of value in correcting overdrainage.

Road Construction.—Roadmaking is of necessity one of the first problems which must be tackled in land reclamation. Where shallow peat is concerned the best policy is to remove the peaty layer and construct the road on the underlying mineral subsoil, but with deep peat such a procedure cannot be followed, and the road has to be constructed on the existing land surface. Fig. 4 represents the cross section of a road on the Macaulay Demonstration Farm, Lewis. Roads of this type have been used extensively in the moorland areas of Germany and Scandinavia. Two ditches 4 ft. 6 in. deep, 4 ft. broad at the top, sloping to 3 ft. at the bottom, and 25 ft. apart, are cut along the sides of the road. The excavated

[1] *The Scottish Journal of Agriculture*, vol. xiii. 51-56, 1930. *Ibid.* xv, 175-176, 1932.

[2] *The Scottish Farmer*, vol. xl, 996. 1932.

material is built up uniformly as shown, until a height of 2½ ft. is obtained in the middle of the road. Two strips, 4 ft. wide, along the ditch sides are left clear, and are later sloped off to a line 9 in. below the surface level of the ditches. At first the camber of the road is rather steep, but as the peat shrinks, the surface assumes a more normal appearance. Main roads should receive a covering of clay or sand to fill up irregularities and form a firm surface, but with side roads it is sufficient to lime and manure the peat and sow out with a grass-clover mixture. It is often found possible to construct a road alongside an existing drain, in which case the latter can be made to serve as one of the side ditches of the road.

THE RELATIVE PRODUCTIVITY OF SCOTTISH, ENGLISH AND DANISH AGRICULTURAL LAND

H. G. Miller, B.Sc.
Rothamsted Experimental Station

In 1929 there appeared a paper on this subject by the former Agricultural Adviser to the Danish Legation in London.[1] It compared the productivity of the arable land in the three countries (Wales being included with England throughout) over four 5-year periods from 1889-93 by expressing the yields of the different crops in terms of their feeding value, so as to get a set of composite figures which would be comparable between the different countries. For this purpose he used the Scandinavian standard, the food unit, which is defined as being equal in feeding value to one kilogramme (2·2 lb.) of barley. Where a table is given in terms of 100 food-units its significance can perhaps best be grasped by multiplying the figures in the table by 2 and taking the resulting figures roughly as cwt. One thousand of these food units make a crop unit, also equivalent to a metric ton (·9842 Imperial tons). Throughout this paper, where yield is mentioned, it means yield as measured in terms of food units.

A study of Faber's paper shows the amazing increase in the productivity of Danish crops since 1889-93, and also shows up in a rather different way the steady decline in British agriculture. As it also gives some idea of what might have been the results here under a different national policy, it is worth while, in view of the present economic situation and the greater attention now being paid to British agriculture, to analyse Faber's figures more closely, with special reference to Scotland. It is not intended here to make invidious comparisons with Denmark, but rather to let the facts and figures speak for themselves. Suffice it to observe (1) that high productivity does not necessarily mean greater prosperity to the farmer; Danish farmers having frequently to work harder and for even less reward than our own, and to submit to a lower standard of living;

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[1] H. Faber, *Jour. Roy. Stat. Soc.*, xcii., 4, p. 559.

(2) that the Danish results are commonly ascribed to the cumulative effect of reorganisation, co-operation, agricultural education and the quick adoption in practice of the results of energetic scientific research—in other words, to the national policy of the country rather than to the superiority of the men engaged in the industry; and (3) that the Danish figures look even more striking because their agriculture was so far behind ours when they undertook their agricultural revolution.

This method of comparison has obvious limitations, which, with present tendencies in British agriculture, stand out more prominently to-day than they did during most of the period covered in the investigation. Food units are not a measure of economic output. The cash return from land under a market garden crop may be much greater than that from the same ground under swedes, although the return in food units may be considerably smaller. Were the productivity of British agriculture, measured in food units, consistently less than that of Denmark it might have little practical significance; but the disquieting fact is the big change in food-unit productivity that has occurred in Denmark, while there has been no similar change in British agriculture, or anything to compensate for it in the nature of a big increase in economic output.

To attempt any real explanation of these different trends in the two countries is beyond the scope of this article. Obviously many factors are involved, including climatic and geographic differences, size of holdings and systems of land tenure, cost of labour, and the proportion of rural to industrial workers, along with the relative merits of cheap imports of food compared with laborious small-scale methods of food production, or less laborious large-scale methods. Equally obviously, the earlier appreciation by the nation of the importance to its welfare of its agricultural industry would have done at least something towards preventing the differences between the two countries from becoming as striking as the figures in this paper reveal.

Comparison of the Arable Area of the Three Countries.—The data forming the basis of this comparison are given in the five sections of Table I, for the preparation of which I am largely indebted to Mr J. R. Moffatt. The first four sections are calculated from data given in Faber's paper, with reference to official figures for the areas and yields of green crops. Where figures have been converted from the metric system, and abbreviated, they may show slight discrepancies from official statistics, and in the totals. The fifth section—added because of the recent acceleration of changes—has been worked out entirely from official statistics, adhering strictly to Faber's methods, fully described in his paper. That this section consists of only two years reduces its reliability, but the yields of crops during 1930-31 were close to the normal (roots, however, were slightly lower), and it reveals the striking fact of the continued rise in Danish yields despite the severity of the depression, with the resulting further decline in production here. "Other corn crops" consists chiefly of beans and peas in England and Scotland, with a small amount of rye. In Denmark it was originally chiefly rye, but mixed corn has increased at a surprising rate until it now shows a greater acreage than rye. The increase in England of "Other roots" is due to sugar beet, which is the chief item in this class in Denmark. "Other green crops" consists of cabbage, rape, rye and vetches, lucerne and catch crops. The acreages and yields of a number of market garden crops, small fruit, and certain crops grown for seed have been omitted throughout from the calculations, but the area of these is relatively very small.

TABLE I

Table of Acreages and Crops in England (including Wales), Scotland and Denmark

1889-1893	Area (Thousand Acres)			Crop Units (Thousands)		
Corn	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Wheat . . .	2,196	56	107	1,775	56	110
Barley . . .	1,874	217	720	1,484	189	508
Oats . . .	1,965	1,007	1,065	1,160	570	498
Other corn crops .	548	24	1,039	396	20	684
	6,582	1,305	2,931	4,814	835	1,800
Roots						
Potatoes . .	397	142	129	572	199	105
Mangolds . .	343	1	57	731	2	120
Swedes and Turnips	1,461	479	68	2,086	830	101
Other roots . .	13	1	33	22	1	71
	2,214	624	287	3,411	1,032	398
Green Crops						
Rotn. grass for hay	1,815	401	525	1,495	367	386
,, ,, ,, grazing	1,278	1,235	1,538	840	804	792
Other green crops .	376	22	264	304	16	106
	3,469	1,658	2,328	2,639	1,188	1,285
Fallow . . .	474	10	481	..	..	..
Straw . . .	..	..	..	1,256	278	447
	12,740	3,596	6,026	12,121	3,333	3,930
1899-1903						
Corn . . .	5,970	1,257	2,879	4,429	792	1,930
Roots . . .	2,034	596	524	3,073	924	850
Green Crops . .	3,603	1,623	2,152	2,890	1,222	1,390
Fallow . . .	321	7	363	..	..	..
Straw . . .	..	..	..	1,087	270	463
	11,927	3,484	5,918	11,497	3,208	4,634

1909-1913	Area (Thousand Acres)			Crop Units (Thousands)		
	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Corn	5,755	1,208	2,834	4,256	810	2,126
Roots	1,972	585	855	3,221	1,052	1,796
Green Crops . .	2,926	1,522	2,167	2,397	1,143	1,859
Fallow	323	7	333	..	..	..
Straw	..	..	..	1,057	255	586
	10,976	3,323	6,189	10,930	3,260	6,368

Table of Acreages and Crops in England (including Wales), Scotland and Denmark

1923-1927	Area (Thousand Acres)			Crop Units (Thousands)		
Corn	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Wheat . . .	1,602	55	215	1,417	58	232
Barley . . .	1,231	141	753	969	124	737
Oats . . .	1,900	937	1,084	1,197	586	758
Other corn crops .	512	10	1,104	347	9	780
	5,245	1,143	3,155	3,930	776	2,507
Roots						
Potatoes . .	485	141	187	699	210	221
Mangolds . .	359	1	260	841	3	644
Swedes and Turnips	797	396	637	1,093	737	1,478
Other roots . .	98	3	100	181	5	265
	1,740	542	1,184	2,815	955	2,608
Green Crops						
Rotn. grass for hay	1,691	409	620	1,541	413	802
,, ,, ,, grazing	846	1,092	1,139	616	773	1,032
Other green crops .	295	28	264	288	26	268
	2,832	1,529	2,022	2,445	1,212	2,102
Fallow	420	7	116	..	..	..
Straw	..	..	..	892	242	808
	10,235	3,221	6,478	10,082	3,186	8,026
1930-1931						
Corn						
Wheat . . .	1,271	51	253	1,032	53	276
Barley . . .	1,025	97	908	767	86	1,004
Oats . . .	1,715	848	947	1,092	537	805
Other corn crops .	393	8	1,132	293	7	921
	4,404	1,005	3,241	3,185	683	3,007
Roots						
Potatoes . .	436	126	162	627	188	220
Mangolds . .	279	1	391	608	3	1,038
Swedes and Turnips	644	367	616	795	629	1,603
Other roots . .	299	2	90	582	2	239
	1,658	496	1,259	2,612	822	3,099

	Area (Thousand Acres)			Crop Units (Thousands)		
Green Crops	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Rotn. grass for hay	1,661	416	715	1,504	420	1,010
,, ,, ,, grazing	842	1,306	1,007	610	923	1,138
Other green crops .	243	26	166	233	19	174
	2,745	1,748	1,888	2,347	1,362	2,322
Fallow . . .	325	6	62	..	..	..
Straw . . .	..	..	..	734	218	856
	9,133	3,254	6,448	8,878	3,086	9,285

The changes in the proportion of land devoted to the various crops in the three countries can be more clearly seen by deducing the following table (II) from Table I. In each period the total area for each country is taken as 100.

TABLE II

Proportion of Arable Area under Different Crops

	1889-93			1899-1903			1909-13			1923-27			1930-31		
	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Corn . .	52	36	49	50	36	49	52	36	46	51	35	49	48	31	50
Roots .	17	17	5	17	17	9	18	18	14	17	17	18	18	15	19
Green Crops	27	46	39	30	47	36	27	46	35	28	47	31	30	54	29
Fallow .	4	..	8	3	..	6	3	..	5	4	..	2	4	..	1

If we take the total area under these crops in the first period for each country as 100, the variation in the total arable area for each period is shown below :

100	100	100	94	97	98	87	93	102	81	90	107	72	90	107

The points revealed by this table are :

(1) The fairly steady balance of the crops in England and Scotland during the first three periods.

(2) The subsequent decline of corn in the last period in favour of green crops in England and Scotland, the increase in green crops (*i.e.* temporary grass) in the latter being distinctly more marked.

(3) In Denmark the steady proportion of corn throughout, the great increase in roots at the expense of green crops, and the elimination of fallows. Even so, the proportion of roots in Denmark has only recently exceeded that in England and Scotland.

The steady proportion of roots in Scotland (apart from the 1930-31 decline) and in England, during the whole forty years, seems at variance with generally accepted beliefs, but this is not so. In the first place the total area under crop is 28 per cent. down in England and 10 per cent. in Scotland ; secondly, potatoes, and latterly sugar beet, have increased at the expense of swedes, turnips and mangolds. Figures showing the effect of this will be given when the situation in certain counties is described.

The relative contribution of each of the crops to the total food production of the arable land is shown in the following table (III), deduced from the right side of Table I. The total crop units for each country in each period are taken as 100.

TABLE III

Proportion of Yield produced by Different Crops

	1889-93			1899-1903			1909-13			1923-27			1930-31		
	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Corn . .	50	33	57	48	33	52	49	33	43	48	32	41	44	29	42
Roots .	28	31	10	27	29	18	29	32	28	28	30	32	29	27	33
Green Crops	22	36	33	25	38	30	22	35	29	24	38	26	26	44	25

In Scotland the three different groups of crops made about equal contribution before the War, but now both Corn and Roots are giving way to Green Crops—that is, temporary leys. The total production has altered as follows, taking the total crop units for each country in the first period as 100 :—

100	100	100	95	96	118	90	98	162	83	96	204	73	93	236

Production in England has decreased to the same extent as the arable area, and in Scotland to nearly the same extent. But in Denmark it has increased out of all proportion to the slight increase in area. This is due to

(1) The increased area under roots. One acre producing 1 ton of wheat or barley may yield, counting the straw, 1·3 crop units ; producing 2 tons of good hay, counting the aftermath, 1·2 crop units ; but producing 8 tons of potatoes, 1·9 crop units ; and producing 25 tons swedes or mangolds, nearly 3 crop units. Labour costs are not the serious item in Denmark that they are here, so that root-growing is less expensive.

(2) The increased yield of the crops grown. In the first period the Scottish yields were, in 100 food units per acre, Corn (omitting straw) 6·39, (low because of the large proportion of oats, of less feeding value than barley), Roots (including potatoes) 16·51, and Rotation Hay (including aftermath) 9·31 (high because loss in value through bad making is ignored). Taking each of these as 100, and expressing the yields for the other countries and the different periods proportionately, we see in Table IV what improvements there have been in yields per acre.

TABLE IV

Comparative Yields of Different Crops

	1889-93			1899-1903			1909-13			1923-27			1930-31		
	Eng.	Scot	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.	Eng.	Scot.	Den.
Corn .	114	100	96	116	99	105	116	105	117	117	106	124	113	106	145
Roots .	93	100	84	91	94	101	99	109	127	98	107	123	95	100	149
Rotn. Hay	87	100	79	93	104	90	93	103	116	98	109	139	97	109	152

These figures are deduced from Faber's paper, Corn (omitting straw) from p. 563, Roots from p. 567, and Hay from pp. 569 and 572,

In 1930-31 the weather resulted in the Scottish yields of swedes and turnips being rather low. Allowing for this, there has been an improvement in yields in Scotland in the last forty years of about 6 to 7 per cent., while rotation hay yields have increased rather more. In England there has been only about half this improvement, apart from hay. Really the situation is even less encouraging, because, as the arable area has declined, presumably the worst land has gone out of cultivation ; this would tend in itself to raise yields. In Denmark the increase in yields, particularly in recent years, can only be described as amazing, evidence showing that the 1930-31 figures are not to any large extent due to particularly favourable seasons.

The foregoing data can be summarised, by dividing the grand totals of crop units in Table I by the respective total areas, giving a table (V) which expresses more eloquently than words the results of two very different national agricultural policies.

TABLE V

Average Yield of Arable Land in 100 *Food Units per Acre*

	England	Scotland	Denmark
1889-1893 . .	9·5	9·3	6·5
1899-1903 . .	9·6	9·2	7·8
1909-1913 . .	10·0	9·8	10·3
1923-1927 . .	9·8	9·9	12·4
1930-1931 . .	9·7	9·5	14·4

One would naturally have expected the Scottish figures to be higher than the English. But whereas England has very little temporary grassland, Scottish arable land includes a large proportion, which lowers the total Scottish yield in food units. Considering the amount of our temporary grassland and the extent of our arable land which is on bare hillsides and close to the rock, the Scottish figures would be below the English were not the standard of farming higher.

On the other hand, figures suggest that the Scottish standard of farming, taking the country as a whole and ignoring the livestock industry, is lower than the Danish. For instance, with turnips and swedes, and also rotation grass for hay, the actual crop yields are :—

	Turnips and Swedes (Tons per acre)		Rotation Grass for Hay [1] (Cwts. per acre)	
	Scotland	Denmark	Scotland	Denmark
1899-1903 . .	14·3	15·4	31·9	27·4
1909-1913 . .	16·8	17·6	31·3	34·1
1923-1927 . .	16·6	19·9	33·1	42·5

The yield in food units of turnips and swedes in Denmark as compared with Scotland is still greater than the above table indicates because of the breeding of roots for high dry matter content, and also because of the much bigger, and still increasing, proportion of swedes to turnips in Denmark ; the proportion is now about 4:1 although it was very much less in the first period. With rotation grass for grazing, the yield in food units is also greater because of the additional fact that Danish temporary leys are shorter.

The actual Danish yields will not appear unduly high to the good Scottish farmer, and the chief explanation of the inferiority of the Scottish averages seems to lie in there being a bigger tail of poor farming in this country to lower the figures of our good men and good districts, further borne out by the relatively low yields of oats as seen in Table I.

In addition there are differences which would repay study between the two countries in the practice of manuring, both with artificials, of which Denmark uses more,[2] and organic manures, especially liquid manure.

So far we have excluded permanent grassland from our calculations. If we now bring it in, this gives a truer comparison between English and Scottish agriculture.

Comparison of the Total Agricultural Land in the Three Countries.—In Faber's paper permanent grassland is deliberately omitted because it has, until quite recently, been of so little importance in Danish agriculture ; statistics for it are, in consequence, very incomplete and unreliable. But, using such figures as are available, the inclusion of permanent grassland, which extends to about only one-sixth of the arable area and is generally unsuited to arable cropping, would probably reduce the Danish figures in Table V by less than 1 unit. For the earlier periods it would scarcely reduce the figures at all.

Table VI gives the area and yield of arable crops and permanent grass (hay and grazing) for England and Scotland.

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[1] In both countries this is nearly all taken from the first year of the temporary ley.

[2] E. M. Crowther, *Jour. R.A.S.E.*, 1931, p. 12.

TABLE VI

		Area (Thousand Acres)				Crop Units (Thousands)			
		England		Scotland		England		Scotland	
			%		%		%		%
1889-1893	Arable . .	12,740	(46)	3,596	(74)	12,121	(53)	3,333	(78)
	Perm. Grass .	14,937	(54)	1,296	(26)	10,563	(47)	942	(22)
		27,677	(100)	4,893	(100)	22,683	(100)	4,275	(100)
1899-1903	Arable . .	11,927	(43)	3,484	(71)	11,479	(50)	3,208	(75)
	Perm Grass .	15,374	(56)	1,411	(29)	10,900	(48)	1,025	(24)
		27,301	(99)	4,895	(100)	22,379	(98)	4,233	(99)
1909-1913	Arable . .	10,976	(40)	3,323	(68)	10,930	(48)	3,260	(76)
	Perm. Grass .	15,960	(57)	1,496	(31)	11,307	(50)	1,084	(25)
		26,936	(97)	4,819	(99)	22,237	(98)	4,344	(101)
1923-1927	Arable . .	10,235	(37)	3,221	(66)	10,082	(44)	3,185	(74)
	Perm. Grass .	15,038	(55)	1,471	(30)	9,887	(44)	1,181	(28)
		25,274	(92)	4,692	(96)	19,969	(88)	4,366	(102)
1930-1931	Arable . .	9,133	(33)	3,254	(67)	8,880	(39)	3,086	(72)
	Perm. Grass .	15,624	(56)	1,575	(32)	10,046	(44)	1,256	(30)
		24,757	(89)	4,829	(99)	18,926	(83)	4,342	(102)

No yields for permanent hay are given in the first period, therefore these have been estimated from subsequent years. In calculating the yield per acre from permanent grass used for grazing, it has been assumed for England that its yield in food units is equal to that of hay including aftermath, and that permanent hay has the same feeding value as rotational. In Scotland the permanent hay yields per acre are high on account of the large proportion of timothy meadows, and the yield from permanent grass for grazing has therefore been taken as only 80 per cent. of that for hay; considering the poor nature of much of the permanent grassland, even this may be too high. The figures in brackets show the subsequent variations taking the total areas and yields in the first period as 100 in each case.

In the forty years the total production, arable and grass, has fallen 17 per cent. in England, while in Scotland it remained almost stationary, with, if anything, a slight increase. But this is due to the permanent grass gaining eight points while the arable lost six. There has been a considerable loss in the area of agricultural land in England, ground presumably reverting to rough grazings, which are, of course, omitted from the table. The area of permanent grass is only now back to pre-war level, a point not generally appreciated, partly because the recent excessive imports of meat (and their greater hold on our markets) give the impression of over-production of livestock at home although home production is only now reaching pre-war levels.

From Table VI is derived Table VII, comparable with Table V.

TABLE VII

Average Yield of Agricultural Land in 100 *Food Units per Acre*

	England	Scotland	
1889-1893 . .	8·2	8·7	
1899-1903 . .	8·2	8·7	
1909-1913 . .	8·3	9·0	
1923-1927 . .	7·9	9·3	
1930-1931 . .	7·7	9·0	Denmark over 13·4

The inclusion of permanent grassland has lowered the English figures by 1·5 to 2 points, whereas the Scottish figures show a decline of only about 0·5 and now show the higher productivity of our agricultural land. Denmark, however, is still far ahead.

Comparisons between Counties.—Comparing the yields per acre of Scotland and Denmark as measured in food units, one naturally feels that our yields are inferior because the yields of the less fertile districts have reduced those for the whole country. If we compared individual counties we might find them competing more successfully with the Danish figures ; we would naturally expect, for instance, that East Lothian could compete with any district in Denmark.

For this purpose, figures have been calculated by the Faber method for six Scottish counties, and also for the Holland Division of Lincolnshire, probably the most productive area in England. Corresponding figures have been supplied by Mr Faber for the best and worst counties in Denmark. These figures are as follows :—

TABLE VIII

Average Yield in 100 *Food Units per Acre*

		Aberdeen	Angus	Argyll	Ayr	East Lothian	Fife	Scotland	Holland (Lincs.)
Arable .	1909-13	8·3	11·4	8·7	9·7	13·5	10·3	9·8	13·2 (1913-14)
	1923-27	8·7	11·6	8·7	9·7	14·3	11·7	9·9	13·9
	1930-31	8·0	10·9	9·1	10·0	13·7	11·9	9·5	12·8
Arable and Perm. Grass	1923-27	8·5	11·1	8·9	10·3	13·5	10·5	9·3	11·9
Per cent. Area under Perm. Grass	1923-27	6	11	58	56	23	31	28	24

In 1923-27 for the arable land the yield for the poorest county in Denmark, Maribo, was 9·75, and for the richest, Ringkøbing, no less than 17·81.

The figures in Table VIII are calculated from the statistics for wheat, barley, oats, beans ; potatoes, swedes and turnips, and mangolds ; temporary hay and pasture ; fallow ; permanent hay and pasture.

A weakness of following the Faber method for different Scottish counties is that it assumes the feeding value of a crop to be the same in different parts of the country, but this probably has very little effect on the final figure. Straw, for instance, amounts to less than unity in the above figures, so that, obviously, differences in its feeding value have a practically negligible effect. Again, in districts where the feeding value of turnips and swedes is greatest, the greater proportion of the area is frequently under turnips with their lower food value, and these two opposing factors tend to cancel each other out.

Thus the best county in Denmark beats the best in this country, and the worst, consisting largely of hungry sandy soil, is well above our poorer counties. In practically every Scottish county there are poor parishes, and possibly the richest parishes in East Lothian or Strathmore would show yields more nearly equal to the best Danish districts. The chances are considerable, however, that the best individual farm in this country has a yield, as measured in food units, below the best individual farm in Denmark.

It will be noticed how steady are the yields from the different Scottish counties, only Fife and East Lothian showing appreciable increases. The inclusion of permanent grass in 1923-27 has altered the figures in the second line of the table (VIII) in accordance with expectation ; Timothy meadows explain the increase in Ayrshire.

During the three periods in the six Scottish counties the proportion of grassland to arable land has increased, the second period being intermediate between the first and the third. In Aberdeen, Argyll and Angus this is due to an increased proportion of temporary grass (the increase being 3 to 5 per cent. of the total agricultural land), in the others to an increased proportion of permanent. (In Ayr the proportion of temporary has actually declined about 2 per cent.). In Holland (Lincs.) the area of permanent grassland has actually declined steadily between each of the three periods, the temporary remaining practically constant.

The following table (IX) arranging the Scottish counties in order of productivity, shows the proportion of the total arable area occupied by each crop, while the figures in brackets give the proportion of the total yield (in food units) due to each of these for the period 1923-27, the total in each case being taken as 100.

TABLE IX

	Holland (Lincs.)	Maribo	Ringkøbing	East Lothian	Fife	Angus	Ayr	Argyll	Aberdeen	All Scotland
Corn	52 (42)	53 (43)	41 (31)	43 (33)	42 (30)	38 (29)	31 (23)	32 (22)	35 (26)	35 (32)
Roots	37 (51)	25 (39)	19 (37)	25 (38)	23 (38)	22 (38)	12 (25)	15 (27)	15 (32)	17 (30)
Rotn. Grass, etc.	9 (7)	21 (18)	39 (32)	32 (29)	35 (32)	39 (33)	57 (51)	52 (51)	50 (42)	47 (38)
Fallow	2	1	1	..	..	..	..	1	..	..

Holland (Lincs.) would be expected from this table to have the greatest productivity. But its root-break contains seven times the area of potatoes that it does of other roots, and the yield has been surprisingly small for such a district. The differences between this district and East Lothian are interesting because of the similarity in yields shown in Table VIII. In the Holland Division the area under roots for stock and potatoes has actually increased since 1909-13 from 49,000 to 60,000 acres (22 per cent.), due entirely to potatoes (with an additional increase of 14,000 acres of sugar beet excluded from the calculation), while in East Lothian roots have declined from 24,000 to 19,000 acres (19 per cent.), due to a decline in swedes and turnips and also potatoes. Yet the total productivity in the Holland division has not risen greatly—the fall to 12·8 in 1930-31 being due chiefly to adverse seasonal effects on yields of mangolds and corn—and in East Lothian has not fallen.

The superiority of Maribo over East Lothian is due to higher yields in all crops, especially roots (where potatoes put East Lothian at a disadvantage, constituting 38 per cent. of the root-break compared with 20 per cent. in Maribo). It is not due to different proportions. The comparative yields in 100 food units per acre are as follows (1923-27) :—

East Lothian—Corn	10·3	Roots	19·8	Rotation Grass	12·0
Maribo — „	11·6	„	28·2	Green Crops	15·0

but the difference between the two has since been widening.

There is evidently a bigger range in productivity between the best and worst counties in Denmark than there is here. The Ringkøbing figures would be even lower were it not for roots which yield 70 per cent of those of Maribo, compared with the corn and green crops which yield only 50 per cent.

The decline in root-growing for stock in Scotland, and still more in England, which has gone on steadily since the first period—23 per cent. in Scotland since 1889-93 and 49 per cent. in England as compared with an increase of no less than 700 per cent. in Denmark—is largely responsible for the absence of any increase in productivity. Where this static condition is due to a change over from roots for stock to potatoes it is justified, but where it is due to economic difficulties and consequently less intensive farming it is to be deplored from the national point of view. This condition can scarcely be remedied by growing more roots for stock unless they can be dealt with much more mechanically than at present, nor is there room now in the potato market for following Lincoln's example.

Corn-growing can be expanded slightly, but apart from perhaps employing a few more workers it would not increase production to any great extent, and with the Scottish climate its desirability is doubtful, unless it were to prove definitely more profitable. The best —and about the only—way of increasing the productivity of our land appears to be to increase the yields of the existing crops in approximately their present proportions, with particular attention to grassland. The practicability of doing this—given favourable economic conditions—is one of the chief conclusions from this comparison. Its desirability may be open to question in present circumstances, but it cannot but be a bad thing nationally when farming loses the incentive to improvement, and bountiful crops become more difficult to find in the countryside.

THE BREEDING OF COLOURED SHEEP

J. A. Fraser Roberts, M.A., B.Sc., F.R.S.E.

Introduction.—Even at the present time there appears to be a demand for garments made of naturally coloured, undyed wool. This section of the wool industries is a small one, but it is capable of considerable expansion. It would be difficult to point out a better example of a case in which the farmer, by appropriate and very simple breeding methods, could meet the demands of the trade for raw materials of precisely the kinds desired in reasonable quantity, and with those defects eliminated that are at present to be found. It is probable that this industry would remain a special and limited one, and that the demand that would be met would remain a luxury demand. It is, however, the case that at the present time some of the more profitable activities in agriculture are those which are satisfying a luxury demand, and in this particular instance there seems to be no reason why the farmer and the manufacturer together should not build up a new and profitable section of an industry.

Considerations that limit the Production of Undyed Fabrics.—Naturally coloured wools are available in the form of black and of brown (including various shades from a fairly deep brown to a light fawn). There is a third type which at the moment is exceedingly rare. This is the peculiar grey colour called "sheila," found very occasionally in the Shetland breed. This last colour must be almost unknown to industry at the present moment, but could probably be made available by breeding. Of the commoner colours, black and brown, brown is the more useful, but the supply of brown wool is at the present time very limited, being confined almost exclusively to the Shetland breed. Black wool, it is true, can be found in connection with almost every breed, but supplies are uncertain and irregular. The manufacturer has probably never contemplated the possibility of obtaining in natural colours all the types of wool that he uses, especially as far as fawn is concerned. As will be pointed out later in this article, black wool and brown wool of any type could easily be produced. The manufacturer, therefore, can be assured that if he wants it, naturally coloured wool of any type, from fine Merino to Scots Blackface, can be produced for him.

One defect in coloured wools as at present produced is the admixture of white fibres. Frequently, for example, an adult black sheep has so much white scattered through its coat that it appears grey. It is true that for many purposes the manufacturer himself might mix his coloured wools with white wool in order to obtain various shades of grey and fawn, but there is no doubt that he would prefer wool of a perfectly uniform colour. If he wishes then to mix white wool with it he would do this under controlled conditions. This defect is one that is capable of being rapidly reduced, and in fact practically eliminated, by breeding. The Black Welsh Mountain breed of sheep is an admirable example of what can be done in this direction. The uniformity of the black coat in that breed is remarkable, the elimination of the white fibres being purely the result of several generations of selective breeding.

A second and more serious defect in naturally coloured wools is their tendency to fade. This can often be seen on the unshorn sheep. The tips of the staples in a black sheep may fade to a rusty brown, and similarly the wool of a brown sheep may fade to a much lighter colour.

The difficulty is sometimes met at present by exposing the cloth to the action of the sun for a considerable period, and so ensuring that the greatest possible degree of fading has already taken place before the cloth is made up. There is no doubt, however, that variations in this characteristic, too, are largely hereditary, and are amenable to selection. Individual sheep can be found that retain the true black or brown colour and exhibit extremely little fading. Again the Black Welsh Mountain breed affords an admirable example of what can be done in a few generations of selective breeding.

There is an additional consideration that to some extent minimises this objection to the use of naturally coloured wools. If fading does occur, it is of a relatively unobjectionable kind. Black wool, which is not really a true black, but a very deep brown, fades to a rusty, deep brown colour, and brown to a light shade of brown. For certain heavy garments of the open-air type the result is not unattractive, and is not for a moment to be compared with the change of colour that occurs when certain dye-stuffs fade. It has nothing in common with the change, for example, from blue to an unpleasant purplish pink.

The adult fleece in many Shetland sheep contains a proportion of long, hairy fibres. If this characteristic were to reappear in crosses with other breeds, it would certainly be an undesirable feature. Once again, however, the experience of breeders has clearly shown that such defects as this can be greatly reduced or eliminated by selective breeding.

The manufacturer anxious to embark upon the production of undyed fabrics might be apprehensive as to the constancy of his supplies. But surely this economic difficulty is not incapable of solution. If the demand were to arise, it should not prove a task of insuperable difficulty to devise a mechanism by which such a supply could be assured.

Some desirable Features of Undyed Fabrics.—It is certain that the production of undyed fabrics has not yet been considered in relation to the full possibilities that exist. Bearing in mind that any type of wool can be produced in black and several shades of brown, and also in all probability as a true grey, that is, with grey individual fibres as in the Shetland "sheila," an attractive vista presents itself. The most casual observation of suits, overcoats, tweed costumes, stockings, socks, caps, and so forth, reveals the fact that quite a large proportion of those at present being bought by the public are made in colours that could be replaced by natural colours. Greys (a mixture of black and white), and more especially browns and fawns of various shades and patterns, appear to be universally and perennially popular. One example that would not be thought to represent a colour within the limits of the possibilities of naturally coloured wools is military khaki. For the production of khaki cloths, wools dyed in the mass are mixed, the colours being white, brown, and a very small proportion of blue. With the exception of the blue, all these colours are similar to natural colours. It is of course the blue that gives khaki its greenish tinge.

There is something specially attractive about naturally coloured fabrics, an elusive quality difficult to describe. Even the slight degree of fading that might occur has its attractive side, and gives to the garments a part of their individuality.

Woollen underclothing appears to be largely made up in natural wools, but at the moment it must be confessed that the almost universal colour, which could only be described as a somewhat dirty white, is very dull. Might it not be that fine woollen underclothing, made up in attractive fawns, possibly with patterns, might prove more effective in competing with the onslaught of artificial silk?

There is a special and important advantage associated with the use of naturally coloured wools that has not yet been mentioned. It has been frequently noted by breeders of coloured sheep and users of their wool that, in the case of a coloured sheep, the wool appears to be of finer quality than that of the stock from which the sheep springs, *i.e.* that in some way the fact that a fleece is coloured is in itself associated with more desirable wool characteristics. It has also been noted that where kemp occurs this is far less obtrusive in the case of the coloured sheep; for example, it has sometimes been stated that the fleece of the Black Welsh sheep is practically free from kemp. In conjunction with my colleague, Miss D. H. Strangeways,[1] I have recently examined this point, and find that these apparent differences, remarkable and striking as they are to the naked eye, are for the most part optical illusions. Coloured fibres, when contrasted with white ones, appear finer to the eye, but the most remarkable effect is in the case of the kemp. Actually, that this effect should be present is not surprising when it is recalled that manufacturers have always stated that their principal objection to kemp is its appearance, owing to its interior refracting surfaces, of not being so well dyed as the other fibres. The objection to kemp, therefore, is not directly due to its coarseness. In the case of naturally coloured black or brown kemp, the fibre is heavily loaded with pigment granules, and with rare exceptions appears just the same colour as the wool fibres. Naturally coloured wool, therefore, represents the only form in which the manufacturer can at the present time obtain kempy wool in which the kemp does not show up sharply, a result that cannot be obtained by dyeing.

Another possibility in connection with the breeding of coloured sheep is the use of their skins as rugs. Sheep-skins make attractive and very durable rugs, and it would be possible to obtain not merely blacks and browns, but, in addition, various patterns, for example, piebalds.

It would appear, therefore, that there are distinct possibilities for building up what is, to all intents and purposes, a new industry, specialised it is true, but nevertheless one of considerable promise. It would be practically a new industry, because the possibilities readily obtainable in practice have so far scarcely been touched.

The Breeding of Coloured Sheep.—In the early days of the rediscovery of Mendel's work, it was hoped that the recognition of Mendelian factors would permit of breed improvement at a hitherto undreamt-of rate. The complexities revealed by the work of the last thirty years, however, have largely falsified these hopes, at least as far as animals are concerned. Simple Mendelism has little to offer at the present time with reference to breeding for meat or milk, but in the breeding for coloured wool there is a field in which Mendelian discovery can be simply and directly utilised in practice.

In technical language a white fleece depends upon a dominant factor. If this factor is not present the sheep is coloured. The colour that appears in all ordinary breeds is black. In the Shetland and some other relatively primitive breeds the colour is brown.

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[1] D. H. Strangeways and J. A. Fraser Roberts, 1931. "Observations on the Apparent Fineness and Freedom from Kemp of Naturally Coloured Wools." *Jour. Textile Institute*, *22*, pp. 488–493.

The difference between black and brown depends upon a single factor, black being dominant.[1]

For the benefit of those who are not familiar with the science of genetics, it may be useful to state the practical consequences, and thus to indicate how black or brown flocks could be built up.

1. True breeding whites crossed to blacks give 100 per cent. whites that are not true breeding.
2. Whites that are not true breeding when interbred give 75 per cent. whites (25 per cent. true breeding) and 25 per cent. blacks.
3. Whites that are not true breeding crossed to blacks give 50 per cent. whites (none true breeding) and 50 per cent. blacks.
4. Blacks crossed together give nothing but blacks.

With regard to the foregoing considerations, it is to be noted that an ordinary white flock is likely to contain a majority of true breeding whites, and a minority of whites that are not true breeding. Browns will not appear in flocks of the ordinary breeds.

5. Blacks crossed to browns give 100 per cent. blacks that are not true breeding.
6. Blacks that are not true breeding, when interbred, give 75 per cent. (25 per cent. true breeding) and 25 per cent. browns.
7. Blacks that are not true breeding crossed to browns give 50 per cent. blacks (none true breeding) and 50 per cent. browns.
8. Browns when interbred give 100 per cent. browns.

It is to be noted that the black sheep cropping up in the ordinary breeds will be all, or practically all, true breeding blacks.

9. Whites that are true breeding (for white) crossed to browns give 100 per cent. whites that are not true breeding either for white or for black.
10. These whites, when interbred, give 75 per cent. whites (of various constitutions), 19 per cent. blacks, and 6 per cent. browns.
11. These whites crossed to browns give 50 per cent. whites, 25 per cent. blacks, and 25 per cent. browns.

It will be seen that a coloured flock could rapidly be built up. The breeding of brown sheep in considerable numbers would be more quickly achieved if use were made of the blacks cropping up in the various breeds. Once browns had been produced in an improved type, they could be used instead of the Shetland for introducing the brown colour into other breeds.

In certain breeds it would be found that some of the coloured sheep showed a pattern of colour and white. Such sheep could be used in the initial period of the building up of a coloured flock.

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[1] A detailed account of the experiments upon which are based the conclusions stated in this section will be found in the two following papers, together with a summary of the literature :—J. A. F. Roberts and R. G. White, 1930. "Colour Inheritance in Sheep. IV. White Colour, Recessive Black Colour, Recessive Brown Colour, Badger-face Pattern, and Reversed Badger-face Pattern." *Jour. Genet., 22.*, pp. 165–180.

"Colour Inheritance in Sheep. V. Dominant Black." *Jour. Genet., 22*, pp. 181–190.

The use of whole-coloured rams would rapidly reduce their numbers in subsequent generations, and finally, they could be allowed to disappear.

Another type of black sheep does exist, however. These are the same in appearance, but the black is dominant to white. In this country this dominant black occurs in the Black Welsh Mountain breed, and in the Piebald or Spanish breed. The results of crosses with whites are the same as those given in 1–4 above, if the words "whites" and "blacks" are transposed in these statements. The use of Black Welsh Mountain sheep would certainly give a black flock more quickly than would the use of coloured sheep of the type occurring in ordinary breeds. On the other hand, the sheep would not be automatically true breeding, and would for a long time throw a high proportion of whites. Also, as far as is known at the moment, there would be no means of turning this dominant black into brown, short of the introduction of Asiatic sheep.

Further Improvement of Coloured Sheep.—Having once obtained coloured sheep, the flock would consist of blacks and of browns, possibly together with a number of whites that were not true breeding if it were desired to add to the numbers of the coloured flock, because these would give a high proportion of coloured lambs. If it were then found that brown wool was much more valuable than black, the use of brown rams exclusively would fairly rapidly reduce the number of blacks and increase the number of browns. Constant selection, however, would be advisable in regard to two of the characteristics already mentioned as undesirable features of coloured wools as they exist at present. These are the tendency to produce fleeces in which white fibres mixed with the coloured ones, and the tendency for the wool to fade. Both these characteristics are readily amenable to selection, as has already been pointed out. A few generations of careful selection should result in a flock of sheep whose fleeces were of uniform colour, free from white fibres, and relatively fast to sunlight. The notable success obtained in the Black Welsh Mountain breed shows clearly that this task is not a difficult one.

During the early stages in the foundation of a coloured flock the breeder might well have whites, blacks and browns. The white wool would, of course, be sold as such, and there would be little difficulty in the sale of a mixed lot of black and brown fleeces, which could then be separated into groups, the browns in all probability according to the depth of the fawn colour shown by them.

Certain General Considerations.—Needless to say, the coloured flocks would be commercial flocks, so that a single cross or even two crosses with another breed, followed by a grading-up process back to the original breed, would not be a very serious matter. The pioneers would certainly have to face the possibility of an unprofitable cross in perhaps a small flock, but once this had been done there should be no loss of money on mutton production, because the coloured sheep would be as good as the white ones from this point of view. The pioneers would receive the reward of a reasonably high price for their coloured rams.

The pleasant feature of Mendelian breeding is its extreme simplicity. Attention can be concentrated on the colours, and these can be produced exactly as desired. Whatever happened, there would be little possibility of loss, because the coloured flock could even more readily be turned into a white one again.

One objection may be urged, namely, that the breeding of coloured sheep might increase the amount of scattered coloured fibre to be found in the wool of the sheep of the country. This idea is founded on a misapprehension and there is no basis for such a view. Heterozygous whites do not tend to show any more coloured fibres than do homozygous whites. The Wensleydale is a special case. It is true that in this breed it appears difficult to obtain true breeding whites, but this is owing to a special feature peculiar to that breed, namely, the dark-faced show type is commonly a heterozygote. The Wensleydale problem, therefore, has nothing in common with the general problem of colour in other breeds.

The Sale of Naturally Coloured Wool.—Even at the present time, certain manufacturers wish to have naturally coloured wools. There are also breeders who are producing a small proportion of such coloured wools. They are not in touch with each other. When the farmer is selling his wool clip a few coloured fleeces decrease its value, and it is only when the buyers have accumulated a considerable number of such fleeces that they are able to sell them. From the user's point of view the supply must be very irregular and uncertain.

The question of marketing is entirely out of my province, but it would seem desirable on general grounds that if naturally coloured wools are produced on any scale, some attempt should be made at the same time to secure their efficient marketing. Possibly in a special case of this sort some centralised organisation for collecting coloured fleeces and passing them on to buyers would serve a useful purpose. The breeder would be assured of a fair price and the user of regular supplies. One imagines that it would not prove difficult for a large private or co-operative organisation to undertake this task.

Summary.—1. At the present time the use of naturally coloured wools for the production of undyed fabrics is only a very small section of the activities of the wool industries. Modern breeding methods, utilising the discoveries that have been made on the inheritance of colour, make it possible for the breeder very simply to produce wools of any type, from Merino to Blackface, in either black or brown. It is very probable that if the manufacturer had made available for him such supplies of coloured wools there would be a considerable expansion of this section of the industry, an expansion that should secure profit both to the breeder and to the manufacturer.

2. The disadvantages associated with the production of undyed fabrics at the present time are pointed out, in particular the mixture of white fibres with the coloured ones in the fleece, and the tendency of naturally coloured wools to fade. Both these undesirable features are capable of very great reduction by selective breeding.

3. A short description is given of the inheritance of the important colours, and it is shown how coloured flocks could rapidly be built up.

THE CONSTRUCTION AND EQUIPMENT OF CATTLE BYRES

I.—Byre Flooring

Alexander Burn Fowler, B.Sc.
The Hannah Dairy Research Institute, Kirkhill, Ayr

There are six essential points which must be considered in selecting the materials used in the construction of byre flooring, namely: durability, resilience, warmth, impermeability, continuity, and roughness.

Durability is necessary if the floor is to withstand the wear which results from the constant treading of the animals on the relatively small areas at their fore and hind feet. If the material is not sufficiently durable, depressions will be formed in these areas, with the result that water and urine will fail to drain off. This in turn will lead to damp and infected stalls, which will inevitably be detrimental to general health, and may result in increased udder troubles.

Resilience, or elasticity, is desirable, especially for heifers which have been out-wintered, since sore feet, bruised knees and swollen hocks are caused chiefly by housing animals on hard unyielding floors.

Warmth is a factor to which little attention has so far been given, but there is no doubt that it is a desirable quality, especially where only a small amount of bedding is available. Apart from the general discomfort to the animal which may result from lying on a cold surface, it should be realised that the functioning udder is particularly susceptible to loss of heat, and that cold floors may well be a contributory factor to the onset of udder disease.

Impermeability to liquids is essential, otherwise the flooring and subsoil will be permeated with urine, and thus be not only permanently damp and cold, but also a site for serious bacterial contamination.

Continuity in the laying of the floor is also essential, since the presence of cracks or crevices between bricks will tend to harbour undesirable bacteria. Moreover, the proper cleaning of the byre floor is made quite impossible where crevices exist, since these may easily be sealed over with dry dung, and thus form permanent centres for the multiplication of harmful organisms.

Roughness of surface is obviously desirable in order to prevent slipping, and thus to limit accidental losses among stock. It is necessary, however, to place a definite limit on the degree of roughness, both for the general comfort of the animal and for ease in cleaning.

Some commonly used Materials.—The types of byre flooring at present in use in Scotland are extremely varied, depending partly on the farmer's own personal choice and partly on the regulations laid down by county authorities. Older types of flooring which were much in favour were clay or cobbles on the fore half of the stall, and bricks or stone flags on the rear half. Although cement concrete has now come into common use, it still remains a relatively common practice to lay the fore half of the stall with bricks,[1] which are found to be more kindly to the feet than the solid concrete. Some farmers who suffer annual losses among their young stock as a result of bad feet, but who are compelled by local bye-laws to use solid concrete floors, make a practice of cutting strong turf and laying it in the fore half of the stall in order to ensure maximum comfort for their stock.

Of the various materials available for byre flooring wood blocks, although warm and resilient, cannot be recommended, as they are neither hygienic nor impervious to moisture. Asphalt blocks are more hygienic, but suffer from the general disadvantages of all asphalt floors, a point which will be emphasised later. Bricks, while warmer and more yielding than concrete, are also un-hygienic, since, however well the floor is laid, it is almost impossible to avoid the development of cracks between the bricks. In cases of contagious disease, such cracks may result in serious loss, since they form crevices for the multiplication of the infecting organisms which will subsequently be widely disseminated at each attempt to clean the byre. Thus in one known instance, contagious abortion caused serious loss in a herd of about seventy cows, and it was only when the brick floor was lifted and a continuous cement floor was substituted that the disease was finally eliminated. It is instructive to note that, when the brick floor was lifted, a layer of evil-smelling, dark-coloured liquid was exposed—a sure indication of serious leakage at the joints between the bricks.

There remain two classes of material which are commonly employed for byre floors, namely, cement concrete, and various preparations of asphalt. During the past three years experiments have been carried out at the Hannah Institute with the object of determining the relative advantages of these two materials.

Cement Concrete *versus* Asphalt Preparations.—Ten stalls were laid with cement concrete, and ten with a proprietary asphalt preparation. The cement floor was treated with carborundum dressing to prevent slip. The asphalt preparation, which was stated to consist mainly of a mixture of cork and asphalt, was strengthened by the addition of granite chips, with the object of increasing durability.

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[1] In Scotland the Dairy Bye-Laws state that "for a space of 4 ft. from the feeding trough the floor may be laid with brick grouted in cement to form a smooth surface."

Twenty in-calf heifers of from 2½ to 3 years old, which had previously been kept in the fields, were subsequently tied up for three days in the stalls. When the animals were again turned out to the fields a striking result was observed. Practically every animal on the concrete suffered from tender feet, and showed evident distress when walking, whereas the animals on the special asphalt flooring showed no discomfort. Moreover, throughout the subsequent three years during which the cement concrete flooring was in use, the animals kept on this type of flooring suffered far more from sore feet, bruised knees, and swollen hocks, than those on the asphalt flooring. On the other hand, the asphalt flooring was distinctly disappointing as regards durability: within two years of laying numerous depressions had formed, extending in some places to half-an-inch depth and to one foot diameter, from which the water and urine failed to drain. These depressions were not so much worn as squeezed or bulged by the combined action of the heat of the hoofs and the weight of the animals.

The asphalt floor appeared, however, to offer such advantages in warmth and resiliency over the concrete floor that an attempt was made to find an asphalt preparation which would also possess durability. With this object two stalls were laid with a special patent road asphalt which had been found to exhibit excellent durability during three years' exposure to heavy traffic. To ensure a fair trial, the new preparation was allowed to set for two weeks before use. Two cows were then placed in the treated stalls. Within twelve hours both cows were standing ankle-deep in the asphalt preparation! This may give some idea of the extraordinarily damaging effect of the localised heat and pressure of an animal's hoofs on an asphalt floor.

After three-years' experience of floors constructed of cement concrete and of asphalt preparations, the general conclusions reached were (*a*) that cement concrete lacked warmth and failed to provide a sufficiently yielding surface for the comfort of the cattle, while (*b*) asphalt preparations lacked the durability necessary for a permanent flooring. Efforts were therefore directed towards the construction of a new type of flooring which would possess neither of these disadvantages. After a number of experiments, the following floor has been devised.

A New Type of Byre Floor.—The construction of the floor will best be detailed under two heads, *i.e.* (*a*) the internal construction, and (*b*) the method of surfacing.

(*a*) *Internal Construction.*—The internal structure of the floor has been planned to conserve heat. The principle involved is to raise the insulating capacity of the floor—that is, to lower the thermal conductivity—by including a large number of tubular air spaces in the concrete bed of the stalls. The thermal conductivity of concrete approximates 0·0022, while that of air is 0·00005, so that the inclusion of sufficient air spaces in the concrete should decrease heat loss to a fraction of that of concrete alone.

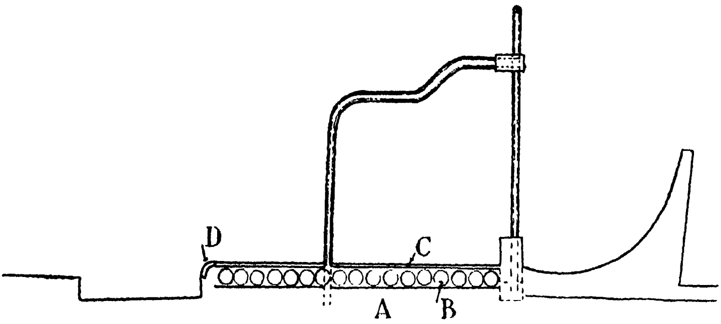

FIG. 1 (*a*).—Structure of new type of flooring, showing foundation concrete (A), tubular air spaces (B) surrounded by cement aggregate, ½-in. layer of special surfacer (C), and rounded kerb of quick hard-setting cement (D). (The stall fittings are of the modern tubular type, with continuous mangers.)

In practice this is accomplished by laying cardboard tubes, of 1½″ diameter, in continuous lengths along the entire length of the stalls, adjacent tubes being laid ½″ apart (see Fig 1 (*a*)). These tubes are held in position on the foundation concrete by a frame, and the cement aggregate is then poured over them, thus filling up the space between the tubes. Sufficient cement aggregate is used to cover the tubes to a depth of about 1½″.

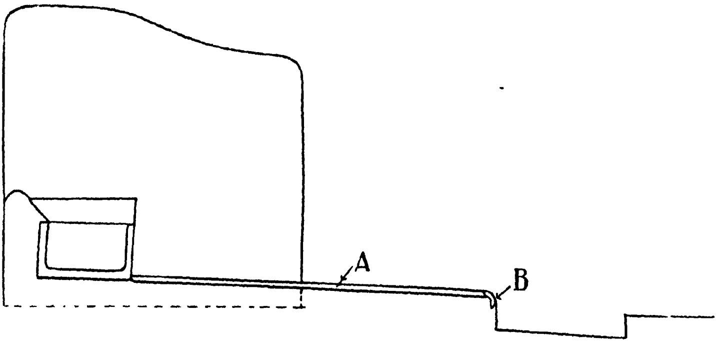

FIG. 1 (*b*).—Re-conditioning of existing concrete floor, showing ½-in. layer of special surfacer (A), and rounded kerb of quick hard-setting cement (B). (The stall fittings are of the common type, with concrete trevices and individual mangers.)

(*b*) *Method of Surfacing.*—After treatment with a special primer, the whole of the concrete is coated to a depth of ½″ with a special surfacer.[1] This product has been found ideal for byre floor surfaces.

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[1] Detailed information may be obtained on application to the writer of this article.

It is smooth, non-slippy, and durable, yet it retains an elasticity which renders it kindly to the feet.

In shaping the floor surface a special feature is the rounding of the kerb (see Fig. 1 (*a*)). The object of this is to diminish the risk of hock bruising, which frequently occurs with a sharp-edged kerb when the animal lies down. The rounded kerb is made with a very quick, hard-setting cement mixture which forms a perfect union with the special surfacer, and gives added strength to the edge of the stall.

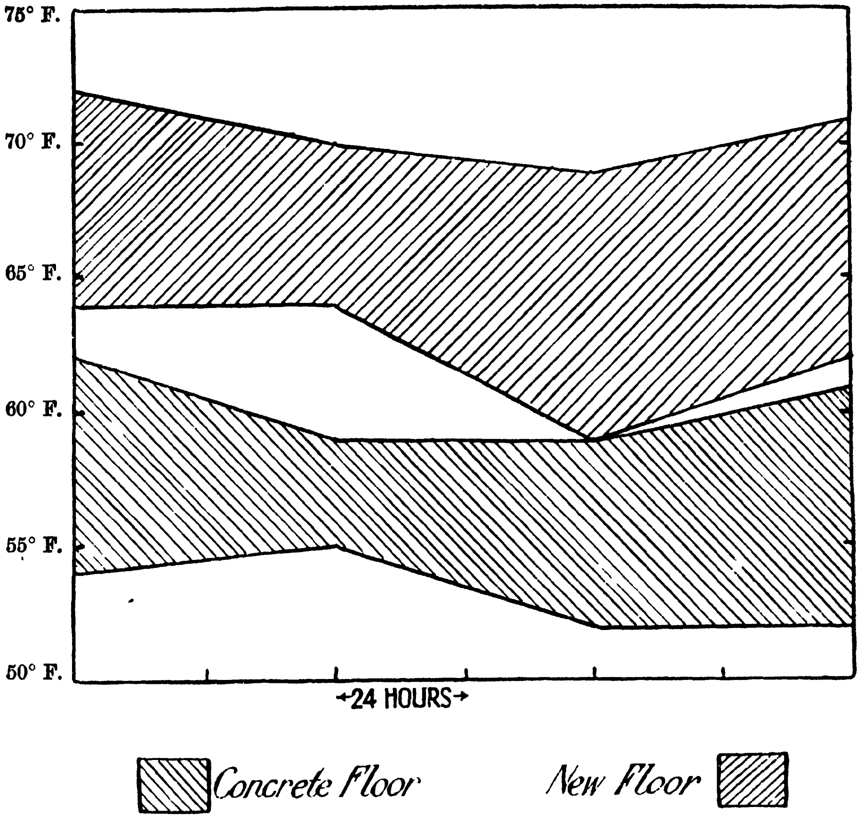

FIG. 2.—Comparison of temperatures (maximum and minimum) of the concrete and of the new floor.

Advantages of the New Type of Floor.—(1) It has already been stated that the internal construction of the new floor is designed to give maximum heat insulation, and thus to provide a warmer "bed" for the animal. In order to demonstrate the effectiveness of this insulation, small cavities have been made under a cement concrete floor and under the new floor, and the daily variations in temperature have been recorded on maximum and minimum thermometers. Fig. 2 shows the results obtained when animals were kept on the two types of floor for six consecutive days, no bedding being provided for this period. It will be seen that the range of internal temperature of the new floor is practically 10° F. higher than that of the cement concrete floor.

(2) After washing the surface of the new floor, the water is seen to evaporate far more rapidly than on the adjoining cement concrete floors. This not only demonstrates the added warmth of the new flooring, but is of practical value in ensuring a dry "bed" for the stock.

(3) As stated above, the special preparation used for surfacing the new floor provides a smooth, non-slippy and durable surface, yet retains a yielding quality which renders it kindly to the feet.

(4) The increased warmth, combined with this resilience, reduces considerably the necessity for bedding the animal with large quantities of straw or litter, thus reducing costs of labour and material in removing and replacing soiled bedding.

(5) The floor would probably be ideal for piggeries in that the warmth of a piggery floor is extremely important, especially in the farrowing pens. It could also be used to advantage in kennels where dry floors and warmth are essential to avoid rheumatism and to prevent dogs "going off their legs."

Reconditioning Existing Concrete Stalls.—There are probably many byres in which the existing cement concrete floors are considered unsatisfactory, but which cannot, for reasons of economy, be immediately replaced. In such cases the existing floor may be reconditioned with the special surfacer at comparatively little cost.

It is unnecessary to pick or scarify the existing cement surface. The latter is merely treated with primer, and the special surfacer is laid to a depth of ½″ directly on to the existing cement concrete, as shown in Fig. 1 (*b*). The special surfacer sets rapidly, and is ready for use within forty-eight hours of laying.

Such a reconditioned floor has a non-slippy, durable and resilient surface, though its heat-retaining capacity is not, of course, comparable to that of the new type of byre flooring already described.

The writer desires to acknowledge his indebtedness to Mr Andrew Kennedy, 10 Princes Street, Ayr, for supplying the material and carrying out the work, thus making the investigation possible.

THE USE OF CHLOROATES AS WEED ERADICATORS

D. Clouston, M.A., B.Sc., and A. Hill, B.Sc., B.Sc.(Agr.)
The North of Scotland College of Agriculture

It is not necessary to emphasise the importance of weeds. The nation loses each year millions of pounds through " the plant which grows out of place." Crop plants are in the main alien to the areas on which they grow, and are not well equipped to withstand the vigorous competition of weeds which, as a result of long selection, are peculiarly well adapted to their respective environments. Indeed, it is only by maintaining eternal vigilance and exercising all his ingenuity that the cultivator can prevent weeds from gaining the ascendancy.

While absolute extermination is impossible, it is essential that their numbers should be kept at a minimum. Cultural operations, since time immemorial, have been the chief means of holding weeds in check. Annuals and biennials are readily killed by mere reversal of the sod ; so too are some perennials. Many of the latter, however, by reason of strong development of underground organs and associated food reserves, are capable of withstanding the most drastic cultural methods of eradication. Indeed, far from reducing infestation, many of the modern implements devised for extreme pulverisation of the soil, lend themselves to dissemination of perennial weeds, since each part detached is capable of becoming an independent plant. Bare fallowing was commonly resorted to in the past to rid land of weeds. This method is still practised but is very costly, especially when to the cost of extermination is added the loss of a crop.

It is not always expedient to employ the foregoing methods of control against weeds because of economic, rotational or climatic considerations. Harrowing, hoeing or other operations involving the movement of soil and the employment of much labour are necessarily expensive. The growing of crops with an innate tendency to foul may be dictated by situation and markets. Yet again, the weather may not permit of the usual cleaning operations at the proper time. For these and other reasons, resort has been had in recent years to chemicals which are particularly useful for the destruction of weeds growing amongst cereals where the orthodox cultural methods are of limited use. Copper sulphate, iron sulphate, kainit, calcium cyanamide and sulphuric acid are probably the best-known herbicides. These chemicals are referable to two groups: (*a*) those such as kainit, which in addition to being herbicides possess a manurial value ; (*b*) those such as sulphuric acid, which are solely weed-killers and a dead loss apart from any control which they exert over the weeds. Kainit and calcium cyanamide are applied in the form of a very fine dust ; the others are sprayed on in solution. The efficacy of these chemicals depends on the fact that they are selective in action. Cereals are narrow-leaved and smooth and, as a result, do not retain much of the chemical, whereas weeds which respond well to this treatment have broad, rough leaves, to which the weed-killer adheres. The weeds are killed while the cereals are not seriously injured. The cereals may suffer initial check but they soon make recovery. Those chemicals have undoubted value for the eradication of weeds like charlock, and have not been exploited to the full.

Though a considerable measure of success has attended the search for chemicals capable of eradicating certain annual and biennial weeds, none has been found heretofore which will destroy coltsfoot, couch and other persistent perennials, without interfering with the continuity of cropping. Such a substance, could it be discovered, would prove of immense value, especially to market gardeners and others practising specialised types of farming prone to fouling. It was with a view to ascertaining how far certain chlorates would meet this requirement that the experiments hereafter described were undertaken in 1930, after certain preliminary work in 1929.

Chlorates are not poisonous in the ordinary sense ; nevertheless care should be exercised in handling them, and pails or other utensils which have contained chlorate in the course of spraying operations should be washed carefully. Cattle have grazed without harm in a field in which extensive areas have been sprayed. Moreover, it was observed that the animals concentrated on the sprayed part, and ate considerable quantities of the sprayed weeds. There may be some risk attaching to the use of the chlorate if the chemical is sown in a lumpy state and the animals permitted to eat much of the concentrated salt.

Against the use of chlorate, it must be emphasised that there is a very definite risk of fire, especially when it is admixed with acids, sulphur or finely divided organic matter such as dust. For this reason chlorates must be stored in such a way that no dust gains entry. Manufacturers have recently adopted the commendable practice of putting out chlorates in metal containers. On no account must these be dropped when handling, as there is risk of spontaneous ignition. It is almost impossible to spray weeds without wetting the clothing with the solution. Unless clothes so damped are washed immediately, before they become dry, there is serious risk of fire. Friction alone is sufficient to ignite such clothing once it has dried. It is advisable to wear rubber boots and a raincoat during spraying operations. Certain inert substances, notably calcium, sodium or magnesium chloride, are sometimes added to chlorates to reduce the risk of fire.

In the experiments here outlined, both sodium and potassium chlorate were used in the earlier trials ; little difference was noted in their potency as weed-killers. The early supplies of chlorates were obtained in wooden barrels, and trouble was experienced through the chemical hardening to such an extent that it could be dissolved only with difficulty.

The relative advantages of " wet " and " dry " applications were tested. The " wet " method proved superior both on grounds of economy and efficacy. It is very difficult to distribute small quantities of the powder evenly over large areas ; moreover, the chlorate must be dissolved before it operates. Dry applications are dependent, therefore, on a subsequent shower of rain. Where widely scattered weeds are being treated in pasture or among other crops, it may be convenient to adopt the " dry " method.

The efficacy of chlorates is directly proportional to the amount of the salt applied per acre. In the experiments described, lethal doses, depending on the weed treated, ranged from 15 to 500 lb. per acre. Concentrations from 15 per cent. downwards have been used with success. It does not appear to be a matter of great importance what concentration is used, provided sufficient water is available to wet the foliage of growing weeds, or to carry the chlorate to the underground parts of dormant perennials.

Spraying has been conducted under diverse weather conditions. It is desirable that at least a short, dry period should follow the spraying, if it is the foliage of the weed that is being sprayed. Rain following spraying, in the case of dormant perennials, is beneficial rather than harmful. It was found, on experimenting with thistles in pasture, that better results followed from wetting the foliage with a fine mist from a sprayer than from applications to the base of the stem. The chlorate applied to foliage is no doubt carried through the vascular (circulatory) system of the plant more economically than that applied at the base of the plant, when some wastage occurs by diffusion in the soil. There is a temptation to burn the dead foliage of the weeds after it has frizzled up. By so doing, however, a certain amount of chlorate is burnt with the stem and is thereby wasted. It was observed that the more vigorous the herbage surrounding the weeds treated, the poorer the results; thus it is easier to kill thistles on fallow or stubble than in pasture. *In spraying perennial weeds, the foliage of which had died down, it was found to be a decided advantage if the land were ploughed prior to spraying.*

Time of Application.—Applications have been made at all times of the year. For annuals of course, treatment must be given when they are in growth; for these, therefore, applications can be made at any time that fits in with the general operations. *Chlorates are not lethal to seeds.*—In the case of perennials, it has been our experience that applications are more successful when made in the autumn than at other times, although on theoretical grounds it might be expected that better results would be obtained when the weed was at the height of its physiological activity—*i.e.* in summer. Moreover, if the continuity of cropping is to be undisturbed by the eradication of weeds, it is well that winter should follow the application.

The time taken by the chlorate to decompose and disappear from the soil varies with the amount applied, the amount of rainfall, and probably with the type of the soil. If there is little rain during the winter, there is a risk of the residual effect of the chlorate causing harm to the subsequent crop. In the case of an application made on 12th December, followed by a somewhat open winter, it was found that the turnips sown on 20th May suffered rather badly, especially on the plots receiving the heavier dressings. In the case of another experiment where the amount of chlorate ranged from 50 to 300 lb.

per acre, no deleterious effect was observed on the subsequent potato crop, planted early in April. Cereals appear to be equally tolerant of the after effects, and grasses recuperate in 2 to 3 months after applications of 200 lb. per acre. Where the dressings are heavier the time of recuperation will be proportionately greater.

As the amount of chlorate necessary to kill different weeds varies within wide limits, it will be convenient to describe the trials with the various weeds separately.

COMMON CHICKWEED (*Stellaria media*, Vill.)

An ideal opportunity of testing the efficacy of chlorates on chickweed was provided in a large garden where a pure crop was flourishing. Five plots, each 48 square yards, were marked out on 25th November 1931, and sprayed by means of a watering-can with a solution of sodium chlorate, at the following rates per acre: 5, 10, 20, 40 and 80 lb. respectively. On the plot receiving 5 lb. per acre the weed was scarcely affected; on the 10 lb. per acre plot a fair proportion of the chickweed was killed; while on the 20 lb. per acre plot not a single plant survived. The plants gradually lost their chlorophyll (green colouring matter) and finally frizzled up and died. The effect of chlorates is apparently cumulative. As might be expected, the weed was entirely exterminated from the plots receiving the higher dressings. An additional plot was laid down on 8th March 1932, at the rate of 15 lb. per acre, to determine whether this reduced dressing would suffice to kill the weed. At first it appeared that the application might prove inadequate. Three weeks after the application was made, however, not a chickweed remained on the plot.

GROUNDSEL (*Senecio vulgaris*, L.)

In part of the garden above referred to, common chickweed and groundsel were growing together in about equal proportions. Six plots were laid down on this area and were treated as in the previous experiment in all respects. About 90 per cent. of the weed was killed in the 20 lb. per acre plot, while not a plant survived in the plot receiving 40 lb. per acre. In order to determine more accurately the minimum effective dressing, an additional plot was sprayed at the rate of 30 lb. per acre. This amount gave complete control.

Evidence of the efficacy of chlorates against a variety of annuals was obtained incidentally in experiments concerned with the eradication of perennials, especially in one series where dressings ranged from 10 to 220 lb. per acre by gradations of 10 lb. The lowest application, viz., 10 lb. per acre, killed a proportion of the annuals; 20 lb. per acre eradicated red dead nettle (*Lamium purpureum*, L.), speedwells (*Veronica spp.*), and cress (*Lepidium sp.*). Willowherb (*Epilobium sp.*) was eliminated with a dressing of 50 lb. per acre.

DAISY (*Bellis perennis*, L.)

While a path was being sprayed, it was observed that even wind-borne spray had killed many daisies on the edge of the adjacent lawn. On this being noted, a portion of the lawn was lightly sprayed with a 5 per cent. solution of sodium chlorate. The majority of the daisies was killed, but the lawn remained in an unsightly condition for a considerable period afterwards. It was obvious that chlorates possessed no advantages over the " sulphate of ammonia-calcined iron sulphate method," for killing rosette weeds among lawn grasses.

COLTSFOOT (*Tussilago farfara*, L.)

Several trials were made with coltsfoot, but since results were uniform, reference need be made only to one which is representative of the others. One of the experimental areas selected was a stubble field so fouled with a mixture of coltsfoot and couch that for several years less than half a crop had been secured. Six plots, each 96 square yards, were marked out on 20th November 1931. The arrangement was such that half of each plot was on ploughed land and half on stubble. Sodium chlorate was applied by means of watering-cans with rose attachment, at the rate of 50, 100, 150, 200, 250 and 300 lb. respectively per acre. The results obtained on the ploughed land were superior to those on the stubble and are quoted below. It was estimated that the 50 lb. per acre application resulted in a 50 per cent. kill, whereas on the 100 lb. per acre plot at least 90 per cent. of the weed was destroyed. Next spring, when growth was vigorous on the untreated portion, no trace of coltsfoot was to be found on the 150 lb. per acre plot. The field was planted with Kerr's Pink potatoes about the beginning of April. When the plots were viewed on 16th June the haulms of the potatoes in the treated area were observed to be considerably stronger than those on the untreated area, because of the freedom from weeds. The untreated area was now heavily infested with couch and coltsfoot. The haulms of the potatoes were slightly paler in colour, especially on the plots receiving the heavier dressings. The yield from the experimental area, however, was considered very satisfactory, despite the fact that the chlorate was applied much too late in the season. Similar results have been obtained for coltsfoot at many centres, but none was probably so striking, in so far as the field in question appeared to have reached the maximum infestation of weeds.

COUCH (*Agropyron repens*, Beauv.)

The data obtained for couch in the experiment described above is fairly typical of autumn applications from other centres; decidedly less satisfactory results followed from summer applications, when the soil proved to be too dry to permit of the chlorate reaching the more deeply situated organs. A dressing of 100 lb. per acre killed the bulk of the couch, while the 150 lb. per acre plot gave complete control. Again, the advantage of ploughing before applying the chlorate was very marked.

COMMON NETTLE (*Urtica dioica*, L.)

A comprehensive trial was made on nettles on ground uniformly covered with this weed, interspersed with a miscellany of other weeds including Bishop's weed, wild chervil, docks and weed grasses. The nettles were reputed to have been six feet high before the ground had been dug for the purpose of sowing down lawn seeds. The nettles along with the other weeds referred to had recovered and were forming a compact braird two or three inches in height, when they came under our notice. Ten plots, each measuring 24 square yards, were treated with a solution of sodium chlorate on 17th April 1932. The dressings applied ranged from 50 to 500 lb. per acre, by gradations of 50 lb. The plots were examined on 24th June, when the top growth on all plots except the 50 lb. per acre plot had been removed. Final observations were postponed until the end of August. It was then found that grass was beginning to establish itself on the 50 lb. per acre plot, as were also dock, wild chervil and nettle. The 100 lb. per acre dressing was almost sufficient for the nettles but inadequate against docks, wild chervil and Bishop's weed. On the other hand, the 150 lb. per acre dressing had completely cleared out all weeds except docks and Bishop's weed. Digging revealed the fact that not only was the surface growth killed but also the underground parts. For wild chervil and nettles, about one cwt. per acre constitutes the minimum effective dressing.

BISHOP'S WEED (*Ægopodium Podagraria*, L.)

Even in the 500 lb. per acre plot, a certain amount of this weed was manifest. Experiments are in progress on an area completely given up to Bishop's weed, in order to determine whether chlorates offer a possible control of this pernicious weed, but results to date do not engender a feeling of optimism.

COMFREY (*Symphytum officinale*, L.)

A field was obtained for experimental purposes, which was reputed to have failed for some years to yield a return equal to the "seed" sown, so heavy was the infestation of comfrey; in places there were as many as one hundred stems of this weed to the square yard. In addition, there was a goodly representation of other weeds, including docks, sheep's sorrel, couch, creeping buttercup, daisies, groundsel and speedwells. It had been the intention of the proprietor, a market gardener, to take an oat crop from the field and thereafter bare fallow it. A section of the field was laid aside for experimental purposes and sprayed with sodium chlorate during the autumn, at various rates per acre. The concentration was also varied. It was discovered that chlorate provided an effective control, and the proprietor decided to spray the whole field at his own expense the following season. Experiment revealed that the concentration of the solution was not an all-important factor, provided that a certain total amount of the dry chlorate powder was applied per acre, and provided that there was at least sufficient water to distribute the chemical. Rain fell during and after certain of the applications, but it in no wise affected the efficacy of the chlorate.

As a result of the experience gained in 1930 a programme including the spraying of the entire field was arranged for autumn 1931, by which time the field was in stubble. Sodium and potassium chlorate respectively, were applied at the following rates per acre, on the 30th November : 106 lb., 142 lb., 177 lb. and 213 lb. as a solution. Each plot measured one quarter of an acre. The chlorates were applied by means of watering-cans each bearing a rose. The plots were laid off in strips each one yard wide, with garden lines to facilitate the spraying operations. All the weeds previously mentioned were still in evidence with the exception of the comfrey—the foliage of which had died down by this time. The remainder of the field was sprayed with sodium chlorate at a rate of 130 lb. per acre. The results were phenomenal. Next spring there was not a comfrey plant to be seen except on the untreated area.

No difference was observed between the efficacy of the potassium and sodium salts. Potatoes were planted about the beginning of April, and by 1st June the untreated area was covered with comfrey plants about 5 inches tall. Counts were made on this date, when it was discovered that there were from 50 to 100 plants per square yard. The potatoes came away without check, and a much heavier crop than usual was raised. The proprietor considered the amount of chlorate required per acre, viz., about one cwt., to be a practicable proposition, even at the price of 30s. per cwt. Docks were not killed but severely damaged, and set much less seed than normally. Sheep's sorrel was also very resistant. Wild white clover appeared profusely on the treated area where there were no potatoes. The stimulus afforded to clovers by these two chlorates has been frequently noted in these experiments. It may be, in the case of sodium chlorate, that the sodium renders potash available to the plant.

This experiment confirmed the results obtained from the small trials in the previous year, viz., that a dressing of about one cwt. per acre in autumn will effectively kill that most noxious of weeds, comfrey.

On 1st June 1931 twenty-two plots, each 24 square yards, were laid down on an adjoining field (an old rose bed), which was also overrun with comfrey, to test the effect of a summer dressing. In addition to the comfrey, there were docks, dead nettles, groundsel, *Lepidium sp.*, creeping buttercup, *Epilobium sp.*, bent (*Agrostis sp.*) and speedwell. The dressings of sodium chlorate ranged from 10 lb. per acre to 220 lb. per acre by gradations of 10 lb. The chlorate was applied as a solution by means of watering-cans fitted with rose attachments. This trial, in addition to providing facts relating to comfrey, shed light on the effect of chlorate on the annuals mentioned—which information is noted elsewhere.

The leaves of the comfrey were scorched even in the 10 lb. per acre plot. Scorching became more manifest, however, as the higher dressings were reached. Despite the scorching, the comfrey did not succumb rapidly until the advent of a heavy shower of rain, after which the action of the chemical became more evident. By the end of August, comfrey had disappeared from the plots receiving 110 lb. per acre and upwards. The efficacy of the summer application was better than had been expected, having regard to the results obtained with other perennials treated at this period of the year. The field had been previously planted with roses, and the digging contingent on the lifting of the latter, undoubtedly resulted in a state of the soil amenable to treatment.

CREEPING THISTLE (*Cirsium arvense*, Scop.)

Extensive trials have been conducted on this weed, both on pasture and on arable ground, over a period of three years.

In pasture.—Fields heavily infested with thistles were obtained at two centres. Sodium chlorate was applied at various rates ranging from 50 to 500 lb. per acre. The chemical was applied in the dry state and also in solution by various methods during both autumn and summer. The dry method is easier but not so efficacious as the wet method of application. About a teaspoonful at the base of each plant suffices to kill the weed, and where there are only a few thistles, this method may commend itself.

The chlorate was applied variously as a 2½ per cent. and a 5 per cent. solution. Where equivalent amounts of chlorate were applied, it did not appear to matter what concentration was employed. A fruit sprayer fitted with coarse nozzle was utilized in most of the experiments. A watering-can was used in a certain number of cases. The " spot " method of treatment, that is application of the chlorate to the base of the weed with the aid of a single jet, had been expected to economise material and to place the chlorate where it would prove most effective. This was not borne out by results, however, for what advantage there was lay with spraying of fine mist on to the foliage. It may be added that the thistles numbered about 50 to 60 per square yard, and the leaves caught most of the spray. At one centre, where the soil was almost a pure sand, and the thistles were only some 12 to 14 inches high, a single application of 250 lb. per acre in the middle of August destroyed practically every thistle. At the other centre, this dressing effected a reduction in the number of thistles from 50 to 20 per square yard. The thistles, it must be said, were at least three times the size of the thistles at the other centre, and the soil could be described as a medium loam. At this centre, the thistles required a total dressing at the rate of 350 lb. per acre for total eradication. The grass on the patches receiving this dressing was killed out entirely ; regeneration took place after several months from natural sown seed. A first application of 2 cwt. was made, followed by a second of about 1 cwt. six weeks later. Two applications are preferable to one, since the first considerably impairs the vitality of the weed, and in addition kills the surface growth and facilitates penetration of the later dressing. Chlorates cannot therefore be regarded as a practicable method of ridding pasture of thistles on a large scale. Thistles in pasture, moreover, can be readily controlled by cutting three times per year, once in June and twice in July, for two or three consecutive years ; but on small patches, and under special circumstances, sodium chlorate might be resorted to for use on thistles in pasture.

On arable land.—Six plots, each measuring 394 square yards, were laid down on 16th December 1931, in a ploughed field. There were from five to six thistles per square yard. Apart from thistles, couch, sheep's sorrel and creeping buttercup were the main weeds. The plots were dressed with sodium chlorate at the following rates : 50, 100, 150, 200, 250 and 300 lb. per acre. Turnips were sown on 20th May 1932. Because of the dry season, brairding was irregular on the field as a whole, but particularly so on the 300 and 250 lb. per acre plots, while the 200 lb. per acre plot was not quite up to the standard of the untreated portion of the field. The 300 and 250 lb. per acre plots yielded poorly, and even the 200 was not so good as the untreated portion of the field. It must be borne in mind, however, as was surmised at the time, that the application was much too late. Had the application been made about mid-September little residual effects from the chlorate would have been discerned. Thistles were entirely eradicated in the plots receiving 200 lb. per acre and upwards. The 150 lb. per acre plot gave about 90 per cent. control for couch, and destroyed the majority of the thistles. The beneficial effects of ploughing the land prior to the application of chlorates has been emphasised elsewhere. The advantage of turning over the sod is clearly demonstrated if comparison is made of the dressings requisite on pasture and ploughed land.

SHEEP'S SORREL (*Rumex acetosella*, L.)

While no land was found bearing a sufficient amount of this weed to provide a special test, it was frequently represented as a casual in other experiments. It proved to be very resistant to chlorate treatment ; an application of 300 lb. per acre did not completely destroy it. About 400 lb. per acre appeared to be necessary.

DOCKS (*Rumex spp.*)

Docks were treated at many centres with sodium chlorate at the following rates per acre : 50, 100, 150, etc., up to 600 lb. The lowest effective dressing at any centre was 400 lb. per acre. This quantity proved inadequate at some centres, especially if the docks were very strongly developed. The best results were obtained when about 200 lb. per acre were watered on with the aid of a watering-can in autumn, and two subsequent applications of 100 lb. per acre given at monthly intervals. This killed most of the docks. A fourth application specially directed to survivors was sometimes found to be necessary. This method of treatment gave better results than when the chlorate was applied in one dressing. It was interesting in one case to note that dock seedlings developed to the number of 230 per square yard on a plot where, two months previous, a dressing at the rate of 400 lb. per acre had been applied. The amount of chlorate required would preclude the use of this chemical in practice except under special circumstances.

RAGWORT (*Senecio Jacobœa*, L.)

New Zealand results (1, 2) have indicated that this weed can be effectively eradicated with as low dressings as 5 lb. per acre. Isolated plants have been sprayed with both a 2½ per cent. and a 5 per cent. solution of sodium chlorate, in the trials under review, but it was difficult to estimate the amount of the chemical required per acre. This weed is certainly readily killed by chlorate, but the amount probably cannot be set at such a low figure for this country, especially having regard to the amount of chlorate required to effect a clearance of certain less robust annuals.

DISCUSSION OF RESULTS

The price of sodium and potassium chlorates was high, viz., 30s. and 33s. per cwt. respectively, when these experiments were commenced ; now the price is about 40s. per cwt. If it were in the neighbourhood of 10s. per cwt., or less, those chemicals would at once play a very important rôle in weed control. As it is, their use will be more restricted. They will undoubtedly be of service in market gardens, where a much higher capitalisation per acre obtains than on the majority of farms. In particular for coltsfoot and comfrey, for which no very satisfactory control exists, it would appear that chlorates present a practicable means of eradication. If the chlorate is applied in October, and preferably not later than September, eradication will go on apace during the dormant months and the soil will be ready for normal cropping next spring, without causing any rotational inconvenience. The appearance of annuals on the treated area—for chlorates have no effect on seeds—will denote that decomposition of the chlorate has occurred and that the soil may be safely planted. For winter annuals a very light dressing of chlorate may be employed, to prevent seeding at a time when the soil is in an unfit state for mechanical elimination of the weeds. Market gardeners, too, have extensive weed dumps. If these were freed from the superficial growth of weeds, many tons of valuable soil would be liberated. Chlorate applied in autumn, will achieve this end by spring. Chlorate could also be used on the accumulating weed dump to kill the more resistant perennials, thus preventing their flowering and active seed-dispersal. Again, where the condition of a lawn is such as to defy cleaning by ordinary methods, chlorates, if applied in autumn, will kill all the herbage. The lawn can then be sown down with a good seeds mixture in spring. Weed seeds will not, of course, be killed and annual weeds will make their appearance, but if hand picked at an early stage, they can be kept down. Chlorates, because of their relatively harmless nature when applied as solutions, are undoubtedly useful for killing weeds by the edges of fields and other places inaccessible to cultural methods of eradication. In Switzerland, extensive use has been made of chlorates by railway companies in the control of weeds along the permanent way, thus largely dispensing with costly manual labour. In this country, the London, Midland and Scottish Railway Company has recently been experimenting with this method of weed control along the track. No doubt municipal authorities will find chlorates of some use in maintaining, weed-free, sand and cinder paths. But as pointed out earlier, drastic price reductions are required to give a fillip to the use of these chemicals. The cost will prove the vital factor in determining the use made of chlorates.

Wet applications where possible will prove most effective, and are more economical of both labour and chemical. A potato sprayer, temporarily converted to give a coarse and downward spray, is quite an effective mode of application for large areas. For small areas, an ordinary watering-can is suitable. Chlorates are generally regarded as non-poisonous. At the same time, if it is convenient, it is probably better to remove animals from areas where spraying is contemplated.

Summary.—1. The value of sodium and potassium chlorate respectively as weed eradicators has been demonstrated for a number of annual and perennial weeds.

2. Application in the form of a solution was found to be most effective. The amount of water is not a matter of prime importance, provided there is sufficient to ensure uniform distribution. A 2½ per cent. solution (5 lb. per 20 galls. water) is a convenient strength.

3. *There is a definite fire hazard in the use of chlorates.*—Instructions as to handling are given, and if these are followed no trouble need be experienced.

4. Annuals can be treated at any time, but decidedly better results follow autumn (September or October) applications in the case of perennial weeds having strong underground organs.

5. The efficacy of the chlorate is much enhanced in the case of perennial weeds, if the soil be previously ploughed.

6. The chlorate decomposes during the winter, and it is possible to proceed with normal cropping in spring. If application be made too late, the subsequent crop will suffer from the residual effects of the chlorate.

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INSECT PESTS—No. XVIII

R. STEWART MACDOUGALL, M.A., D.Sc., LL.D.

INSECTICIDES

IN the series of articles that have been appearing in the *Journal* we have taken a general review of insects of the four Orders that contain the majority of the farmer's insect enemies, viz., the Butterfly and Moth Order; the Beetles; the Flies; and the Green Flies, Scale Insects and Bugs. In the species chosen for detailed mention limitations of space have restricted the choice of examples to those attacking farm crops, though for illustrative purposes now and again some fruit enemies were noticed.

In this closing article of the series it is proposed to review the subject of Insecticides—the materials used to control and destroy insect pests in washing and spraying, dusting and fumigating.

In combating the rarely absent insect enemy the knowledge of experts in different branches of science must be pooled. The zoologist brings a knowledge of the habits and life history of the pest; the botanist is acquainted with the constitution of the host plants; the chemist is concerned with the poisons used in the preparation of insecticides; the engineer provides the spraying, dusting, and fumigating machines. Above all, the farmer must do his share by taking all practical steps by cultural operations, suitable rotations, and cleaning of land to ensure the effectiveness of the measures taken.

Against such a formidable team of workers, assisted by Nature in the way of environment unfavourable for the insect—cold, changes of weather, rains, high winds, and animals of all kinds that prey upon and parasitise insects—it might seem that the insect enemies of crops had little chance of the mastery. In view, however, of the great numbers of insects, their powers of rapid multiplication and of adaptation to surroundings, all possible measures are necessary for successful control.

"Insecticides" as a branch of Insect Control—We shall review the subject under the main headings:

Stomach Poisons
Contact Insecticides
Fumigants.

For a proper understanding of these it is necessary to look briefly at the mouth-parts and the respiratory organs of the insect.

Insects may be divided into two categories, the chewers and the suckers (a few can both chew and suck). The chewers have hard horny jaws and related mouth-parts by means of which they bite off pieces of leaf or fruit or seed or root or plant tissue, and swallow it in small pieces.

When the leaves or other parts on which it is feeding are sprayed or dressed with certain poisonous materials, the insect, eating and swallowing these, takes also the poison covering them, and is killed. Such a poison is known as a Stomach Poison. Examples of insects attacked by a stomach poison are caterpillars of all kinds, beetles and their jawed grubs, locusts and grasshoppers.

The other set of insects—the suckers—cannot take solid food. Their mouth-parts are modified into piercers and a sucking tube, or sometimes are fitted only for sucking up liquids. The piercing mouth-parts are thrust through the skin of the plant organ, and the plant juices pumped up on their way to the stomach. Such insects are treated by contact insecticides which, to be efficient, must reach and come in contact with the body of the insect itself.

An insect has no lungs, and in breathing does not take in air by the mouth. The air enters and leaves by a series of little pores, called spiracles, down each side of the body (they are easily seen by the naked eye in a pale-coloured caterpillar); these spiracles lead into tubes known as tracheæ, which branch and, becoming finer, penetrate to every part of the body.

A contact insecticide, applied as liquid or dust, acts by plugging up the spiracles, so preventing the entrance of oxygen that the insect is suffocated ; or the insecticide on application may give off a gas which penetrates the tracheæ and not only acts injuriously on them, but inhibits normal action of organs of the body.

Examples of insects, with piercing and sucking mouth-parts against which contact insecticides are used, are the Aphides or Green Flies, Scale Insects, Jumping Plant Lice.

In some cases, because the adult insect or its larva cannot be reached by a stomach poison or an actual contact poison, or because of other circumstances, a fumigant is used as the destructive agent. The material vaporises and the gas or vapour penetrates to the insect and destroys it. Fumigants have a great use against granary weevils, and a number of other store pests, in fumigating nursery and other stock under cover, in ridding greenhouses of certain enemies, and in destroying grubs in the soil, and even against larvæ in burrows in the roots of plants.

Stomach Poisons

With a stomach poison the endeavour should be to have the spray or the dressing applied *before* the insect has done the damage. An insect calendar for the crop plant or fruit tree should be available for consultation, and a knowledge of the life-history of the insect and the stage in which it is most vulnerable are necessary.

Of all the stomach poisons none has been used so much as arsenic in some form. It is not enough that the arsenical preparation used should kill the insect pest ; it must not harm the worker, it must not damage the plant, and the residue of poison left on the plant after treatment must not endanger the life or health of the man or other animal that may use the plant or fruit.

The earliest used arsenical was Paris Green—employed a little later than the middle of last century against the Colorado Beetle on potatoes in the United States and against the Codlin Moth of the apple. It is an aceto-arsenite of copper. Paris Green in suspension in the water kills chewing insects quickly, but there is the risk of scorching the sprayed foliage. The strength of the spray-mixture has to be gauged very accurately, the strength varying with the hardiness or the tenderness of the plant. The possible harm to the plant was ascribed to the presence of free arsenious oxide, and to neutralise this lime was added as a component of the spray fluid, in quantity equal to or somewhat over the amount of Paris Green. Further, the Paris Green is rather easily washed off by rain. These drawbacks kept experimenters active until, at last, the discovery of arsenate of lead in the early eighteen-nineties made Paris Green lose pride of place.

As an example of a Paris Green formula, there may be quoted that recommended[1] for use against the caterpillars of the Raspberry Moth, when in early April they leave their winter shelter and crawl up the canes to burrow into the shoots :

Paris Green Paste . . .	1 oz
Quicklime.	1 lb.[2]
Water	10 gallons

The lime is slaked to a cream with a little water ; the Paris Green paste is worked up with a little water and added to the lime and water. Paris Green does not dissolve in water, and therefore agitation of the fluid during spraying is necessary to keep the Paris Green in suspension.

It is important to keep in mind that Paris Green is a poison, and care should therefore be taken so to store it that there may be no accidents. Should Paris Green be an ingredient in a combination spray (see below), remember that it should not be used with soap-solutions or with lime-sulphur.

Paris Green is a favourite poison in fighting certain soil insects, *e.g.* surface caterpillars and "leather-jackets," by the method of poison baits. This method of controlling the "leather-jacket" was detailed in an earlier article on Dipterous Enemies, but a general formula may be quoted: 1 lb. Paris Green, 30 lb. bran, and water sufficient to wet the bran without soaking it (say 2 gallons). This suffices for an acre. Treacle is generally added to make the bait more attractive.

Arsenate of Lead.—This is now the most widely used of all stomach poisons. It does not kill insects quite so quickly as Paris Green, but it is not nearly so dangerous to the health of the plant or tissue sprayed ; it remains longer in suspension in the water of the spray fluid, and it adheres better and longer to foliage and sprayed parts.

This is a case where it is wiser to buy arsenate of lead already prepared, owing to the uncertainty of the raw materials.

There are two forms of lead arsenate: the acid and the basic; the former, which contains a higher percentage of arsenic, is the one in general use ; in exceptional cases the basic form is used. The latter takes longer to act on the insect, and from a third to a half more in quantity is required; it does not harm the most tender plants. Lead arsenate is sold in the paste form with a high-water content (which varies though a 40 per cent. water standard is aimed at), and as dry powder ; the latter is recommended.

Lead arsenate is made up for use with water, in which it does not dissolve but remains in suspension. The strength of the mixture varies considerably according to the aim, the time, and the weather. An average formula is 1 lb. arsenate of lead to 15 to 20 gallons of water. In this strength it is in common use against the caterpillars of the Magpie Moth, and against the caterpillars of the Gooseberry and Currant Sawfly. When the water of the spray evaporates a coating of the poison is left behind. One complication arises. Arsenate of lead is poisonous to bees, which may lap up some of the poison; further, the fruits must not be sprayed. The safe limitation for arsenate of lead, therefore, is to spray with it before flowering and after the harvesting of the fruit; the late arsenate of lead spray attacks the young Magpie Moth caterpillars before they go into winter quarters, which they do when only partly grown. Fortunately there are other stomach poisons serviceable against the caterpillars of the Magpie Moth and the caterpillars of the Gooseberry and Currant Sawfly (see below).

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[1] Collected Leaflets on Insect Pests of Fruit Trees. Ministry of Agriculture and Fisheries.

[2] The purpose of this high proportion of lime is to ensure a better coating over the raspberry shoots.

Remember that arsenate of lead is a poison, and must be kept with care. In a combination spray it should not be used with soaps, but it can be combined with lime-sulphur, milk of lime, and nicotine sulphate. Arsenate of lead, Paris Green, and other arsenicals, also nicotine, being poisonous compounds can only be bought from one licensed to sell poisons, and the buyer must sign the "poison book."

Other Arsenicals.—There is a number of other arsenates and arsenites poisonous to chewing insects—perhaps calcium arsenate has been the most frequently tried—but either they have not proved sufficiently useful or they have proved too harmful to the plant, or they have not been tried out yet. One must bear testimony to the United States Chemistry Department and the Insecticides Division of the United States Department of Agriculture not only for pioneer work, but also for constant research and experimentation.

Other Non-Arsenical Chemical Stomach Poisons.—Experiment is active in testing the fluosilicates of sodium and some other bases, and good results are hoped for. Another poison that has considerable use against the biting lice of poultry is sodium fluoride. It is an excellent treatment against cockroaches and some other household insect pests. It must not be used on plants. It is a poison and the worker with it should not inhale the dust. Constant working with it irritates the skin.

Plant Products as Stomach Poisons.—*Hellebore.*—This insecticide is obtained by grinding the roots of White Hellebore (*Veratrum album*) or Green Hellebore (*Veratrum viridis*) to a powder. The roots contain a poisonous alkaloid. The poisonous principle is volatile, it does not last very long, and this enables hellebore to be used on fruits such as gooseberry and currant, and within three weeks of the harvesting of the fruit. The price of hellebore forbids its use on an extended scale. The spray is in the strength of 1 lb. hellebore to 10 gallons water. *Veratrum album* and *Veratrum viridis* are Liliaceous plants, and must not be confused with the Ranunculaceous genus Helleborus to which our garden Christmas Rose belongs. Hellebore, poisonous to insects, is not nearly so toxic to the higher animals. It requires to be used fresh, and so must be carefully kept in closed receptacles.

Pyrethrum.—The poisonous principle here is a volatile oil given off from the powdered flower heads of several species of pyrethrum. Pyrethrum should be used as fresh as possible, and can be used safely on fruits if necessary, as the poisonous effect passes away in a very short time. As a spray the formula is, 1 lb. pyrethrum to 5 gallons of water.

Derris.—This is an extract from the roots of an East Indian and Chinese plant containing principles—one of them specially toxic—poisonous to insects. As Polvo, mixed with soap and water, it has had great success against the larvæ of the Ox Warble Flies.

Contact Insecticides

Keep in mind that it is of no use with these insecticides to coat the leaf and stem, the insect's body must be reached.

Tobacco in decoctions, as dust or powder with a carrier and as fumigant, has been long known in its use against insects. The active principle is nicotine, which kills very quickly, and as a contact insecticide has the great advantages of not harming plant tissue in the strengths used, and of being able to be used in combination with the above-mentioned arsenicals, with soaps, with lime-sulphur, and with fungicides. Against soft-bodied insects, especially, *e.g.* Aphides and Thrips, nicotine sprays are destructive. Nicotine is extracted from refuse tobaccos. Several grades are in the market under various trade names in the form of nicotine sulphate.

To do its work satisfactorily a nicotine sulphate spray should contain 0·05 per cent. of nicotine. The best-known American brand of nicotine sulphate contains 40 per cent. by weight of nicotine, and this is diluted for use. For a spray the formula is 1 part to 800 parts of water. In order to liberate the nicotine from the nicotine sulphate or to favour its liberation, soap dissolved in hot water is added in the proportion of 2 lb. to 40 gallons of water. The soap solution is also helpful in spreading the spray and aids it in sticking. A nicotine formula given by the Ministry of Agriculture for use, for example, against Aphides and the caterpillars of the Gooseberry and Currant Sawfly and against Apple Sucker and Capsids, is :

Nicotine 98 to 99 per cent.	¾ oz.
Soft soap	½ to 1 lb.
Water	10 gallons

Remember that nicotine is a deadly poison, and that therefore great care should be taken in looking after it. It should always be kept under a good-fitting cover. If vegetables or green fruit have been treated with nicotine, it is safer not to gather these earlier than a fortnight from the time of treatment.

Soap.—Soap solutions have for long been in use for house and garden plants against Green Fly. Household soap may prove efficient. The majority of the soaps sold for spraying purposes are fish-oil soaps prepared with caustic potash or caustic soda, but a vegetable-oil may be used (*e.g.* soya-bean oil soap). A general soap formula is 1 lb. of soap to 4 gallons of water. Soaps to-day are used not so much for their own value as a contact spray but as an aid in spreading the spray, or in serving as an emulsifier of oil, when in combination with other suitable materials. Soap solution may hurt tender foliage.

Paraffin-Emulsion.—Oils of various kinds have an insecticidal importance, but the risk to the life of the plant is too great for their use undiluted. Therefore the oil is used in emulsion. As oil and water won't mix, soap may be used to bring them together, the result being—in a satisfactory emulsion—that the emulsifying agent forms a thin film or layer round minute separated oil globules. Paraffin-emulsion was for long the best known and most used of these oil-emulsions, but partly because other oils are, in emulsion, not so dangerous to the health of the plant or tree, and partly because other substances do the work better, paraffin-emulsion has dropped a little out of favour. The formula for paraffin-emulsion varies. For winter use on dormant plants a formula is: Paraffin, 1 gallon; Soft water, 1 gallon; Soap, 1½ to 2 lb. For summer use: Paraffin, 1 or 2 pints; Water, 1 gallon; Soft soap, 1 lb. Dissolve the soap in the hot water, stirring so that all is dissolved. Remove the soap solution from the fire, and while still boiling pour into the paraffin. Churn very thoroughly until a cream-like emulsion results. This churning is of great importance to prevent the oil and water from separating. Further the emulsion should not be exposed to the air. For use dilute 1 gallon of the emulsion with 10 or 15 or more gallons of water according to the vigour of the plant. The winter strength is used, for example, against the Apple Mussel Scale; the summer strength against soft-bodied insects.

There are other soap-emulsions made with distillate oils and with lubricating oils. Other emulsifiers than soap may be used (hard water is a difficulty with soap-emulsions), and the workers at the Missouri[1] Agricultural Experiment Station have brought forward two emulsions requiring no heat in their preparation (cold-mixed emulsions), one where calcium-caseinate was the emulsifier, and another where a freshly-made Bordeaux Mixture (formula, 2 oz. of copper sulphate, 3 oz. of hydrated lime, and ½ gallon of water) was used for each gallon of oil.

Sulphur.—Three terms may be defined, viz., "Flowers of Sulphur," "Flour of Sulphur," "Liver of Sulphur." Flowers of Sulphur is the name given to the yellow powder which is deposited when the fumes from boiling sulphur are condensed. Flour of Sulphur is the name given to the fine powder produced by a thorough grinding down of "stick" or "roll" sulphur. This boiled with lime and water gives lime-sulphur solution. Liver of Sulphur is potassium sulphide, a substance which, in solution in water, is serviceable against Red Spider; it has only a slight value as an insecticide, its chief use being as a fungicide against powdery mildew and on ripening fruits.

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[1] *United States Department of Agriculture Farmers' Bulletin,* No. 1666.

Lime-Sulphur.—Sulphur and lime when boiled together combine to yield several salts, two at least of which, soluble in water, are useful in the effort to control insects and fungi.

Concentrated lime-sulphur is useful in three ways. It can be used as a winter wash for cleaning dormant fruit trees and destroying wintering Scale insects. The Ministry of Agriculture formula for application in winter and before the buds burst in spring is:

Lime-sulphur (1·3 sp. gr.)	3 quarts
Water	10 gallons

Secondly, it can be used as a summer spray—formula:

Lime-sulphur (1·3 sp. gr.)	3 pints
Water	10 gallons

when it has insecticidal value against developing Scale insects, preventing their settling on fruit and rendering it unsightly. It is not recommended for vegetable crops. Thirdly, it has great fungicidal value. Some kinds of apples and gooseberries are sensitive to lime-sulphur, and against these the summer spray should be reduced to 1½ pints to the 10 gallons of water. Lime-sulphur should not be combined with soaps, nor with soap-emulsions, nor with Paris Green, but may be used with arsenate of lead if hydrated lime[1] be added.

A drawback to the use of lime-sulphur is that the spray, being caustic, is irritating to the workers, whose faces and hands need protection. It spoils harness and leather, and is disagreeable to horses.[2]

Dusts and Dusting—A good many of the stomach poisons and some of the contact insecticides named above, and some not named, may be dusted over the plants or the insects in the form of a powder, sometimes undiluted, sometimes mixed with a carrier. Arsenate of lead, calcium arsenate, sodium arsenate (in a poison bait), white arsenic (in a poison bait), Paris Green, hellebore, have all their uses in powdered form against chewing insects. Tobacco and nicotine dusts are also in use; derris can be used as powder diluted with a carrier; and powdered pyrethrum has a great vogue against certain house pests and some animal parasites. There has been considerable experimentation in dusting and very marked progress, due in measure to the great improvement in dusting machinery from hand-bellows to light engines, tractor dusters, and powerful engines.

A particularly interesting development is the use of aeroplanes in distributing insecticides. Hoppers holding the insecticidal dust are fitted into the plane, and as the powder is released it is distributed by the air rushing past the quick-moving machine and by the air from the propeller which give the dust a downward tendency. In wide areas of more or less uniform level with thousands of acres of crop plants, where the planes can fly low—from 10 to 20 feet—and over forests—Canadian and European—there have been encouraging results.

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[1] Hydrated lime is stone lime ready slaked, not air-slaked lime.

[2] "Insecticides and Fungicides," by H. L. Fulmer, B.S.A., M.A., *Ontario Dept. of Agric. Bulletin*, 302, September 1923.

Fumigants

These are poisons, to the insect, in the form of gases. They prevail against both chewing insects and sucking insects. Their use is against insects in the soil; against insects at the roots of plants, and in some cases inside the roots; against insects ravaging man's food stores (*e.g.* granary weevils, the beetles of pea and bean and other pulses, moth caterpillars that riot among food-stuffs); against house pests; in ridding mills and factories of insect enemies; in fumigating greenhouses and nursery stock; and in trying to make sure that imported plants or plant products carry in with them no live alien insects.

Hydrocyanic acid gas.—This insecticide is used against insects infesting stored grain, and against insects characteristic of greenhouses, *e.g.* Mealy Bug and other Scale insects, and White Fly, although it, of course, kills other greenhouse insects not so difficult to fight as these. It is also used to fumigate nursery stock. The fumigation must be done in an enclosed space or house which must be rendered air-tight. Hydrocyanic acid gas is generated by treating sodium cyanide with sulphuric acid.[1] "The sodium cyanide should be of the quality known as '130 per cent.' and the sulphuric acid should be of a specific gravity of not less than 1·53." The gas is colourless, and has a "stinging" odour. As it is somewhat lighter than air it diffuses chiefly upwards. It does not take fire and is not explosive. *It is a most dangerous poison* to man and other animals, death taking place rapidly if the gas be breathed. No operator dare remain in the room when the gas is being generated. The gas is also destructive to plants when the dosage is too large.

The gas is generated in earthenware pots which are arranged along the floor. Each jar holds a measured quantity of water; the proper proportion of sulphuric acid is poured into each jar; the charges of sodium cyanide which have been already weighed out in the proper proportions are then added to the earthenware jars and the operator, who has been working towards the door, immediately leaves and locks the door. The work is done at dusk and the house kept closed till the next day, when doors are opened and the house allowed to ventilate thoroughly before any one enters. While the proportions of the water, sulphuric acid, and sodium cyanide remain the same, or almost the same, whether living plants are involved or tender plants are present, the dosage varies considerably. Space does not allow of details of formulæ and the hydrocyanic gas fumigation requires such care that general statements are not sufficient. The reader is therefore referred to the Ministry of Agriculture Leaflet. Enough has been said to show that only skilled and knowledgeable workers should attempt to carry out fumigation with this gas.

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[1] "Fumigation with Hydrocyanic Acid Gas," in Collected Leaflets of Insect Pests of Farm and Garden Crops, Ministry of Agriculture.

Calcium cyanide.—This comparatively new product gains in prominence as a means of providing hydrocyanic acid gas without the necessity of using sulphuric acid ; the gas is generated when the calcium cyanide dust is exposed to the atmosphere. The calcium cyanide is spread uniformly on the floor or on the walks in the greenhouse, or on newspapers. Several calcium cyanide preparations are on the market, differing in the amount of hydrocyanic acid gas given off, so that dosage must be a matter of experiment. Generally it may be stated that while ¾ lb. of 88 per cent. calcium cyanide per 1000 cubic feet of space may be the dose for an air-tight store or a mill where plants have not to be considered, a ¼ oz. or even less per 1000 cubic feet might be the dosage in a carefully-closed greenhouse.

Remember that by themselves both calcium cyanide and sodium cyanide are deadly poison.

Carbon bisulphide.—This is an almost colourless, evil-smelling liquid, which vaporises quickly on exposure to the air. The gas or vapour is 2½ times heavier than air, and so sinks downwards from the containers or dishes into which it has been poured for fumigating purposes. The liquid and the gas are inflammable and explosive, so no flame of any kind must be brought near, and, of course, the operator must not be smoking. The fumes are most unpleasant and cause headache and sickness, and would prove fatal to one persistently breathing them. Yet bisulphide of carbon is one of the best of fumigants against insects in food stores or in grain ; it is also effective against insects in the soil, but too expensive to be used on a wide scale for this purpose. Insect infested grain or food stocks are fumigated by being placed in air-tight containers, dishes containing bisulphide of carbon being laid on top of them. The containers or the house should be kept closed for twenty-four or thirty-two hours and then ventilated. 5 lb. of bisulphide of carbon will do for 1000 cubic feet of air space, or ¼ lb. in 50 cubic feet. A favourable temperature is 70° F. to 75° F. ; the temperature should not be less than 60° F.

Carbon tetrachloride is sometimes used in place of bisulphide of carbon as it is not inflammable. It has not the killing power of bisulphide of carbon, and needs to be used in double the quantity.

Nicotine.—This is a common fumigant for greenhouses. Refuse tobacco may be burned with liberation of nicotine, or free nicotine may be vaporised by heating or painting on hot pipes. Fumigation with tobacco should not be done in bright sunshine.

Sulphur dioxide—from burning sulphur—is used as a fumigant against insects. It spoils the germinating power of seeds and discolours and bleaches fabrics that have not been removed.

Paradichlorobenzene.—The peach-tree borer of America, a caterpillar of one of the Clearwing Moths, makes galleries into the cambium of the trunk at soil level and lower. For years there was no very satisfactory way of controlling this pest. Now crystals of paradichlorobenzene ($C_6H_4Cl_2$) are placed in a circle round the base of the trunk, soil at the ground level being removed for the purpose. The ring is 1½ in. wide and 1½ in. from the trunk. When the crystals are in position a mound of soil is placed over them and gently firmed with the back of a shovel. The crystals vaporise; the vapour is heavy and passing down reaches the burrows of the caterpillar, which is killed. The crystals must not touch the trunk. The resulting vapour is non-inflammable. The temperature of the soil should not be less than 60° F.

Tetrachlorethane.—The Cheshunt Experiment Station Reports have familiarised us with this fumigant against white fly in greenhouses. The liquid is poured on the paths of the house at nightfall, 1 pint for every 1000 cubic feet of space. The liquid vaporises. The operator must not remain in the greenhouse, which should be kept closed for 24 hours. Two applications necessary, as eggs are not killed, at intervals of a fortnight if temperature be 70° F. to 80° F.; the intervals are longer at lower temperatures.

Naphthalene.—This has use as a repellent to certain insects.

Bordeaux Mixture.—Some readers may wonder why this wash has not been described. The reason is that Bordeaux Mixture is essentially a fungicide, not an insecticide, though it has a deterrent effect on some insects. By adding arsenate of lead, however, a combined spray is got, useful as a preventive and remedial measure against some insects and fungi. Bordeaux Mixture should not be used in combination with oil sprays or soaps.

RECLAMATION AND CULTIVATION OF PEAT LAND IN LEWIS—IV

W. G. Ogg, M.A., B.Sc., Ph.D.
Macaulay Institute for Soil Research
and
Angus Macleod, B.Sc.
North of Scotland College of Agriculture

The establishment of the Macaulay Demonstration Farm on an area of barren peat moss near Stornoway has been described in previous articles in this Journal.[1] Work was commenced in January 1929, and most of that year was occupied in the erection of buildings and fencing, and in draining, liming, and cultivating a limited area. Liming and cultivation were continued in 1930, and a considerable amount of land (25 acres) was put under crop. The work of bringing in fresh land was continued in 1931, and at the end of that year about 60 acres had been cultivated or improved for pasture.

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[1] *The Scottish Journal of Agriculture*, vol. xiii. (1930), xiv. (1931), xv. (1932).

During the same period numerous experiments were laid down with a view to determining the most suitable methods of cultivation, the amounts of shell sand which should be applied, the kinds and quantities of manures which were required, and the varieties of crops which would do best on peat land under the climatic conditions in Lewis. Much still remains to be done along these lines.

Dairying was commenced in May 1930, when four pure-bred tuberculin-tested Red Poll cows were purchased, and about the same time a beginning was made with poultry-keeping.

In 1932, owing to the financial depression, it was decided to reduce expenditure as far as possible, and to concentrate on the production of marketable commodities. The dairy herd was therefore increased to twelve cows, and the poultry work considerably extended. This resulted in a great increase in the receipts for milk and eggs, and although considerable amounts of foodstuffs had to be purchased during the year, the results of the year's working (considering that the farm was a peat moss in 1929) were not unsatisfactory. During the twelve months ending 31st December 1932, the farm receipts (excluding endowment) amounted to £1060, and the running expenses, including experiments and a certain amount of draining and road-making (but not allowing for depreciation) to £1200.

The experimental programme was somewhat curtailed in 1932, but it is hoped to extend this side of the work, and to increase the area under cultivation when financial conditions improve. Some assistance with cultivation (by means of the Fräse or Rotary Moor Cultivator, the Hankmo, or Rotary Spade Harrow, and a German Moor Plough) was given to crofters who were reclaiming land, and the Red Poll Bull was sent on loan to a crofting township for two months during the summer.

As the farm has not facilities at present for rearing young stock, the calves are sold, usually to crofters, and thus a certain amount of improvement will be effected in the cattle throughout the island.

Climatic Conditions during the Year.—The rainfall for 1932 at Stornoway was 46·88 inches, practically the same as the previous year, and about 3 inches below the average. The wettest month was January, with 10·45 inches, and the driest February, with 0·59 inches. March, May, June, and July were also fairly dry months. The hours of sunshine were 1144·9 for the year, and April to August were the sunniest months, each having over 130 hours sunshine. The mean maximum temperature for the year was 52° F. (the highest being 60·9° F. for August and the lowest 46·2° F. for December). The mean minimum temperature for the year was 42·9° F. (the highest being 51·3° F. for July and the lowest 36·6° F. for April).

Draining, Cultivation, and Road-making.—Much of the land requires further draining, but this has been postponed, partly for financial reasons, and partly because of the need for further experimental work before undertaking an extensive draining programme. The main drainage channel (a stream running through the farm) and some of the open drains which run into it were cleaned out and deepened at the west side of the farm, and an experiment has been laid out with secondary drains at different distances apart. These secondary drains will be left open until shrinkage of the moor has taken place, and wooden box drains will then be laid. A considerable amount of extra draining and cultivation was done on the vegetable garden. Very little fresh land was brought under cultivation during the year, but part of Field II was recultivated by means of the Hankmo or Rotary Spade Harrow. A road, constructed on the lines followed on peat land abroad, was made from the steading to the stream which runs through the farm. This is described in detail elsewhere.[1]

Cropping.—The policy pursued during the year was to produce as much food as possible for the increased dairy herd. About 17 acres of oats or mashlum, grown in 1931, were sown out with grass seeds. Part of this grass crop was cut for hay, and part used for grazing. In addition, areas of mashlum and oats for the silo were grown, and an attempt was made to improve the pasture on other parts of the farm.

Hay.—A second year's crop of hay was obtained from an area of 3½ acres in Field I, which had been sown in 1930 with a mixture of Italian ryegrass, timothy, cocksfoot, alsike, and red clover. The whole area received a dressing of 3 cwt. 18 per cent. basic slag, 2 cwt. 30 per cent. potash salts, and 1 cwt. nitrate of soda per acre, and with a view to ascertaining whether heavier manuring would give an appreciable increase in yield, the area was divided into four strips, three of them receiving one each of the following additional dressings, the fourth receiving only the basal dressing .—

1. 3 cwt. 18 per cent. basic slag per acre.
2. 2 cwt. 30 per cent. potash salts.
3. 3 cwt. basic slag + 2 cwt. potash salts.

Half of each of the four strips also received an extra dressing of nitrate of soda at the rate of 1 cwt. per acre.

The crop was rather patchy, probably because of inequalities in drainage and depth of cultivation, and this interfered to some extent with the experiment. Sample areas were cut and weighed from each plot, and the results showed a fairly heavy yield where only the basal dressings had been applied. There was an appreciable increase from the application of the extra nitrate of soda; extra phosphate and potash together gave a response with the double dressing of nitrate of soda, but with the simple dressing they depressed the yield. The basal dressing of phosphate and potash, however, was reasonably heavy, considering that this area was not being manured for the first time.

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[1] Peat Mosses, II. I. M. Robertson. See p. 169.

In Field III the following grass seed mixtures were sown with the oats in 1931 :—

	East Side	West Side
Timothy	12 lb. per acre	15 lb. per acre
Perennial ryegrass . . .	8 ,, ,,	..
Smooth-stalked meadow grass .	2 ,, ,,	1 ,, ,,
Rough-stalked meadow grass .	..	1 ,, ,,
Wild white clover . . .	2 ,, ,,	..
Wild white clover cleanings .	.. ,,	12 ,, ,,

The east side was cut for hay and the crop was moderately good. The smooth-stalked meadow grass ripened before the other plants in the mixture and was over-ripe before the hay was cut, so much of its value was probably lost. A manuring experiment was laid out on this side of the field to compare different nitrogenous manures. Bad drainage and wet weather at time of harvesting, however, rendered the test useless—the plots near the drains being much better than those farther away.

The west side of the field was grazed as the grass was rather patchy and short.

The west side of Field IV was sown out in April 1931 with oats and a grass seed mixture consisting of

20 lb. Italian ryegrass per acre
4½ lb. Alsike clover ,,
2 lb. Red clover ,,

Part of this area was manured with slag and potash and gave a good yield of hay. Another part, which received a dressing of farmyard manure, gave a disappointing yield.

Pasture.—The best established pasture on the farm is on Field VI, which was laid down in June 1929. At the time of seeding it received a dressing consisting of sulphate of ammonia, superphosphate, ground mineral phosphate and potash salts, and this was followed by a dressing of sulphate of ammonia in 1930 and of nitrate of soda in 1931. In the spring of 1932, as the pasture began to show signs of deterioration, it received the following dressing per acre :—

1 cwt. nitrate of soda
2 cwt. 30 per cent. potash salts
3 cwt. basic slag

This gave a marked response, and the improvement was well maintained throughout the summer. In 1930 the field of 7¾ acres produced 8 tons hay and provided pasture for six cattle for 2½ months : in 1931 7 cattle were grazed for 3 months, and in 1932 9 cattle for 2½ months. An account of the condition of this pasture in the summer of 1931 has been given by Clouston.[1]

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[1] *The Scottish Journal of Agriculture*, vol. xv. No. 3. "The Establishment of Pasture on Virgin Peat." D. Clouston.

Pasture Improvement.—In the northern section of the farm various areas were treated with a view to improving the natural pasture and to producing new pasture at a low cost. Two acres to the north of Field VI, which were dressed with composts, harrowed and sown out with grass and clover seeds in 1930, showed a marked improvement in 1931. Early in 1932 they received a dressing of about 12 tons per acre of dung with very satisfactory results. The heather, scirpus and other native plants are gradually dying out; grasses such as crested dogstail, timothy, and cocksfoot have become well established, and in places there is a luxuriant growth of wild white clover. As this area is fairly flat, the plots become rather soft in wet weather, but with a few surface drains this can be remedied at little cost.

Other portions of the northern section of the farm, which were treated in the autumn of 1931 with a cheap manurial dressing, and sown out with grass seed and clover cleanings (see Part III of this series), have made promising progress where natural drainage was reasonably good. On flat wet areas, however, there has been little or no improvement, and it is clear that in any attempt to establish good pasture in this way, attention must be given to drainage. Even where the land was not even harrowed, the seeding and manuring were fairly effective, but probably additional manuring from time to time will be necessary to keep up the improved conditions.

So far, the best pasture on the farm is on Field VI where the land was limed, cultivated, manured, and sown out with good seed mixtures, and under certain circumstances this method is probably the most economical in the end. There are, however, many areas where it is necessary to limit the outlay, or where the ground is too rough and uneven for cultivation, and under these conditions the simpler and cheaper methods of treatment should be found useful.

Plots of Grasses, Clovers, etc.—A large number of small plots of individual grasses, clovers, and other pasture plants was laid down in the autumn of 1931, and half of each plot received a dressing of shell sand. In July 1932 timothy, cocksfoot, ryegrasses (perennial and Italian), canary grass, crested dogstail, fine-leaved fescue, roughish meadowgrass, wild white clover, and late-flowering red clover had the most promising appearance, and in most cases the limed half of the plot was distinctly better than the unlimed. In 1932 another series of plots was laid down. Each plot was manured with slag, potash salts and nitrate of soda, and half of each received a dressing of shell sand. Of the leguminous crops two plots were sown, and one was inoculated whilst the other was left uninoculated. Beans, peas, and clovers were decidedly better on the plots which received shell sand, but there was no improvement in the case of lupins. Inoculation gave a marked improvement in the case of beans, but in the other leguminous plants nodules were found on roots in the uninoculated as well as the inoculated plots. Beans, peas, and tares were poor crops, however, in all the plots.

Oats and Mashlum.—Oats were grown on the east side of Field IV. The ground was cultivated with the Rotary Cultivator (Fräse) in 1930, and in 1931 received a very light dressing of shell sand (½ ton per acre), and a mixture of fish manure, ground mineral phosphate, superphosphate, and potash salts. When the oats were sown in the spring in 1932, the following mixture was applied :—

2 cwt. calcium cyanamide per acre
6 cwt. 18 per cent. basic slag ,,
3 cwt. 30 per cent. potash salts ,,

An excellent crop was obtained, which stood well. It was cut for silage just before ripening.

Mashlum was grown in Field II on an area of about 6 acres. This land was cultivated by the Rotary Cultivator, limed, and oats grown in 1930 ; potatoes were grown on part of the field in 1931. In 1932 the land was cultivated by means of the Rotary Harrow (Hankmo), and most of the area sown out with oats, Italian ryegrass, timothy, alsike, tares, red clover, and wild white clover. A small section of the field was devoted to a test of various legumes in silage mixtures ; beans (English tic and carse), peas (English maple and dun) and tares (English and Swedish) were tried with oats and clovers. Five different mixtures were used, and inoculation was carried out, but in none of them did the beans, peas, or tares prove successful. Probably the cause of failure was lack of depth of cultivation. In the garden where cultivation was deeper and humification had gone further, beans and peas were grown successfully.

On the same area a manurial test was carried out. The south half of each of the five silage plots received per acre 1½ cwt. sulphate of ammonia, 3 cwt. 18 per cent. slag and 2 cwt. 30 per cent. potash salts, and the north half received the same phosphate and potash, but 2 cwt. nitrate of soda instead of 1½ cwt. sulphate of ammonia. There was not a marked difference, but the crop on the nitrate of soda area was rather heavier and of a darker green colour.

Vegetables.—The results obtained in 1931 were so encouraging that the vegetable area was increased in 1932. About a third of an acre between the steading and the main ditch was drained by means of open ditches, manured and planted with cabbages. An excellent crop was obtained, and in adjoining areas satisfactory results were obtained with carrots, lettuce, parsley, celery, and onions. Early potatoes (Duke of York) grown on raw peat in the garden were a heavy crop, and were marketed in Stornoway in the beginning of July at a good price.

With draining and cultivation the vegetable area is becoming humified to a considerable depth, and during the past three years a decided improvement has been seen in the growth of deep-rooted vegetables. Part of this area was at one time particularly wet, but it is now well drained, and there were indications last year during the dry period that one or two spots were over-drained.

Dairying.—One of the main functions of the farm is to demonstrate clean milk production, and to increase the supply of milk on the island. Although local production is now greater than it was a few years ago, milk has still to be imported from the mainland.

During 1932 the number of cows was increased to 12, and from 20 to 25 gallons of bottled milk were sold daily, mostly in Stornoway, but some is sent by motor bus to Tarbert, Harris, thirty-six miles away. The demand for bottled milk from tuberculin-tested cows is at present greater than the supply, and the milk receipts for the twelve months amounted to over £900.

Considerable amounts of feeding-stuffs had to be purchased, but the results of the dairy side of the farm's activities were highly satisfactory, and the amounts of hay and silage grown on the farm will be gradually increased and the pasture improved.

Poultry.—The winter conditions at the farm are still rather unfavourable for poultry keeping ; the ground round the houses is wet and boggy, and there is little or no shelter from the high winds. During heavy rains the poultry houses were flooded occasionally during the past year, and windows were blown in several times. In spite of these adverse conditions, satisfactory progress was made, and the Rhode Island Red breed has proved suitable for conditions on the island. From 1st October to 31st December 1932, 42 pullets were trap-nested, and the average production per bird was 37 eggs. About 50 more pullets (late-hatched) began to lay in December and January. The poultry receipts for the year amounted to £125.

Trees and Shrubs.—The conifers (chiefly Mountain Pine and Sitka Spruce) and certain shrubs such as rhododendrons, olearia, and cotoneaster have made good progress during the year in places where drainage was reasonably good. The deciduous trees—sycamore, alder, poplar, ash, and birch—which were planted in the spring of 1932, have suffered a set-back from the high winds which are so frequent ; the hazels planted in 1931 have been almost completely destroyed by wind.

Poultry Schemes and Crofters' Prizes.—The scheme for the improvement of the poultry industry, which was commenced in 1930, has been continued. It is functioning not only in the four districts in which Mr Macaulay set up breeding-units, but in many other parts of the island. All crofters with poultry of the selected breed (Rhode Island Red) who follow the advice of the County Instructress of the North of Scotland College of Agriculture regarding feeding and management, can send eggs to a depot in Stornoway where they are tested, graded, and marketed. The number being dealt with has increased to about 200 dozen a week, and the demand for these eggs is such that they can be sold wholesale to merchants at higher prices than crofters receive by retailing them.

The scheme of prizes for crofters was continued for the fourth year, and a championship class open to winners of first prizes in previous years was added to the competition.

The total number of entries was 378, and a sum of £209 was distributed in prizes. The judges reported further progress in draining, fencing, and cropping, and the general management of crofts, and crofters are undoubtedly benefiting from the healthy rivalry aroused by these competitions.

Grass Runs for Poultry

THE following article is contributed by D. H. Robinson, B.Sc., N.D.A., Head of the Biology Department, Harper Adams Agricultural College:—

With the great increase in the poultry population of these islands during the past few years, and the probability of a still further increase as the result of marketing and tariff schemes, the question of the adequate provision of suitable grass runs is likely to become serious.

As to the desirability of a stretch of turf upon which poultry may exercise themselves there is little or no disagreement amongst poultry authorities. Despite the success of "battery" methods of rearing domestic fowl, and the satisfactory results frequently obtained from the close confinement of laying birds, the majority of poultry-keepers are likely to carry on their business in the traditional way, allowing as much exercising space per bird as circumstances will permit. This is the more natural method, and if persisted in may assist to check the all too rapid spread of certain poultry diseases which some veterinary authorities in this country consider to be due to undue forcing for egg production, and the concentration of great numbers of birds within narrow confines.

If exercising ground is to be given, a good grass turf is much to be desired. Not only is it better for the birds themselves than bare ground, which is apt to become indescribably dirty in wet weather, but it also provides at little cost some of those valuable food constituents which fresh green vegetable matter alone can provide.

The problem of keeping a reasonably good turf for poultry is most acute where the birds are all confined in pens, and where the land is stocked to its fullest capacity, with the resultant impossibility of "resting" the pens in rotation. On the general farm, where there is a large range, there is no such difficulty, although there are certain interesting points in this connection which will require mention. At official laying trials the birds are usually allowed so much run that, with intelligent management in very wet weather, the turf can be maintained in fair condition. Even here, however, local conditions of soil and climate may make it difficult to keep the grass as well as could be desired.

From a poultry farmer's point of view the ideal grass run would have a turf composed of dwarf, compact, hard-wearing species, decidedly winter-green, and preferably forming very little top during the early summer. One of the great disadvantages of grass in the average poultry run is that part, at least, has to be cut during the flush of summer. At the National Institute of Poultry Husbandry, which is situated in a district where grass grows very readily, some of the pens have to be cut twice in a season if they are to be kept in decent order. This is a considerable expense, and one of the problems which is being tackled here is the alteration of the flora with a view to reducing this expenditure of time and money. Birds are poor grazers, and although they may, during the winter, seriously damage a turf, they are incapable of keeping down vigorously growing grass in a wet district unless very closely folded upon it.

In reading the following account of the preliminary experiments and observations upon the flora of poultry runs at the National Poultry Institute, it is necessary to bear in mind that this Institute is situated in the extreme eastern side of Shropshire, where conditions are naturally favourable to the production of grass. The larger part of the poultry plant is set out on a slight northerly slope, upon a well-drained Bunter Sandstone formation. The rainfall, which on an average amounts to only 25·6 inches per annum, is nevertheless distributed over 165 days in the year. Conclusions formed at this station will consequently not necessarily be applicable to areas less favourably situated, as, for example, in the Eastern Counties.

Part of the land upon which the plant was laid out some six years ago had previously been sown down with a seeds mixture of a rather complex type, in which Cocksfoot to the extent of 4 lb. per acre was included. It is now generally recognised that small seedings of Cocksfoot frequently lead to a tufty, unsightly type of turf, and there is little doubt that the seeds mixture employed in this case was unsuitable for the formation of poultry runs. The land favours the growth of Tall Oat Grass, and many of the pens have now developed into an unsightly collection of large tufts of Cocksfoot and Tall Oat Grass, with a sprinkling of huge tussocks of Tall Fescue. During the winter months these tufts are connected up by a sole consisting largely of the Poas or Meadow Grasses, but in summer much of certain pens becomes a forest of tall culms, penetrated only with difficulty by the hens.

This natural tendency to form a rough herbage was encouraged in certain instances by the type of run constructed when the Institute was first laid out. Some of the runs attached to the laying houses take the form of long, narrow rectangles, 40 yards long by 8 yards wide. It has been observed repeatedly that the birds dislike moving far from their houses in this type of run, especially during the summer.

They prefer to take their exercise close to the house, with the result that the grass at the far end grows practically unchecked throughout the season and consequently develops into coarse irregular tufts. Area for area, a square run is more attractive and gives more exercise to the birds than a long narrow one. From the point of view of giving an even turf it is much to be preferred.

Although a great deal has been published recently about the effect of grazing and mowing upon the botanical composition of grassland, very little attention has been paid to the problem of turf formation and maintenance so far as poultry are concerned.

For some time this question has been studied by the writer, with the co-operation of the late Director of the N.P.I., Dr Parkhurst, and Mr Howes. It is not necessary here to go deeply into the experimental methods employed : instead, a brief summary of the work will be given, together with some conclusions based upon results so far obtainable.

The primary task was to obtain first-hand evidence as to the effect of poultry upon the different grass species. To this end some small runs were sown down and replicated early in 1931 with rectangular areas, each consisting entirely of one of the following grass species : Perennial Rye-grass (commercial), Perennial Rye-grass (indigenous), Smooth-stalked Meadow Grass, Rough-stalked Meadow Grass, Crested Dogstail, Hard Fescue, Fiorin. Late that summer, when the plots were strongly established, birds were run on them hard for a time, and were then removed. Observations were made upon the wearing capacity and the power of recovery (an important point in turf run maintenance) of the various species, and these were checked by reintroducing the birds.

So far as this small trial went, there could be no doubt as to the superiority of Rough-stalked Meadow Grass and Crested Dogstail over the other species. These two grasses formed a close, well-knit turf, in contrast to the rye grasses which, although growing well, were inclined to be tufted, with much bare space between. Smooth-stalked Meadow Grass was slightly inferior to the Rough-stalked species. Fiorin quite definitely was not suited to the conditions, and long before the other species showed signs of wear it had practically disappeared. Hard fescue, also, was almost absent in a number of the replications, and looked very poor in others.

It had been intended to include New Zealand Creeping Bent Grass or Brown-top (*Agrostis tenuis*) in the trial, but for various reasons this was not done. Good reports of the behaviour of this grass under poultry have, however, been received from Mr T. L. Ward, Cokhay, Repton, near Derby (who, acting on the advice of the county agricultural organiser, sowed down some poultry runs with a half-and-half mixture of this grass and Smooth-stalked Meadow Grass), and from other sources. It is hoped to test this grass and certain types of Red Fescue on similar lines.

These preliminary trials were backed up by an examination of the flora of a large number of pens, both on the N.P.I. plant, the Harper Adams Laying Trials, and elsewhere. From the information gathered by such means, it became apparent that a suitable *basal* seeds mixture which should be successful over quite a large area might be compounded as follows :

Rough-stalked Meadow Grass	4 lb. per acre.
Smooth-stalked ,, ,,	4 ,, ,, ,,
Creeping Bent	3 ,, ,, ,,
Crested Dogstail	2 ,, ,, ,,
	13 ,, ,, ,,

To this should be added a proportion of *indigenous* Perennial Rye-grass in an amount depending upon the manner in which this species flourishes in the particular district where the sowing is to be made. In those districts where Perennial Rye-grass grows extremely luxuriantly, it might be desirable not to include it at all, on account of the danger of its crowding out the dwarf species during the early stages of turf formation and its subsequent degeneration into a patchy tufted condition. In other cases it might be an advantage to include 6-8 or even more pounds per acre : but care should be taken to obtain true indigenous seed, as the commercial types might easily ruin the turf from a poultry-keeper's point of view. It is a species which should be used cautiously until experience of it under poultry conditions has been obtained.

Where poultry are to be kept on a fairly free range, the inclusion of 1 lb. of English Wild White Clover would assist in the rapid formation of a sward. Even in those cases where the ground is to be divided up into small pens, the inclusion of a *small* quantity of this clover might be desirable, although under such intensive conditions the plant soon disappears. It nevertheless assists to cover the ground in the early stages, and so helps in keeping out weeds.

Confirmation of these opinions was unexpectedly received last November from a well-known firm of seed specialists in the north of Shropshire. The managing director, who had read a popular article on this subject by the writer in a farming publication, kindly sent along details of the basic mixture of grasses that the firm have been recommending for poultry runs. With the exception of Perennial Rye-grass, of which rather more was included than desirable from the writer's experience, the prescriptions were very similar indeed.

The establishment of a sward with such a mixture is relatively easy. Its maintenance is a more difficult matter because poultry-keepers demand so much from their grassland. They stock it heavily and continuously with a scratching animal, manure it with very large amounts of nitrogen, frequently neglect to mow it, or take the birds off in wet weather, and still expect it to remain in good condition. They, unlike the rest of the agricultural community, graze grass with one form of stock alone, which is against all the principles of pasture management.

On most poultry farms, in order to keep the grass in good condition, it must either be regularly mowed, or regularly grazed with something other than poultry. Mowing, as has already been mentioned, is expensive and inconvenient. Grazing with some other class of stock would seem to be the better and more efficient plan. The two most suitable types of grazing animals for this purpose are geese and sheep.

The older writers on agriculture believed that geese and goose dung had a very bad effect upon land of any description. For example, Worlidge, in his *Systema Agriculturæ* (1689) says : " Goose dung hath been held by the Antients to be most hurtful and unprofitable to any Grounds. They say that to good Grass they are a great enemy, for their Dung and treading will putrifie it, and make it worse than barren."

This may be the case where geese are confined for too long upon one stretch of ground, but where they are shifted as soon as they have grazed down the herbage, they appear to exert an extremely beneficial influence. On one or two fields at the N.P.I. they have had an effect very similar to that brought about by the intensive system of grassland management which involves the application of considerable quantities of nitrogenous fertiliser. The dense, young, bright green, vigorous-looking grass which follows grazing by geese, is in strong contrast with the extremely dark green, rather flattened vegetation found, for example, on the neighbouring duck pens.

The systematic folding of a small flock of geese over a poultry turf should be possible in many poultry plants, and ought to assist very considerably in maintaining it in good condition.

Sheep, of course, are employed in a number of poultry plants to keep down the grass and, provided a docile breed is used, they are very successful. The grass responds well to the biting and tearing of the animals, and is stimulated into a lateral form of growth which the birds are unable to encourage. At present prices they seem to offer a cheap, and in the future, possibly a profitable, form of turf maintenance.

Notes from Agricultural Colleges

Boghall

General.—The 1932 season was favourable for experimental work from the point of view of weather conditions. The season suited most crops, but particularly cereals and potatoes.

Cereals.—A replicated trial again demonstrated the beneficial effect of dressing seed oats with Ceresan. The normal rate of seeding for Victory oats in the district is about 5 bushels per acre. Seedings of 3¾ bushels and even of 2½ bushels per acre where the seed was treated were found to give as good results as the normal rate (5 bushels) untreated. It is worthy of note, however, that in the trials, both at Boghall and at various centres in the College area, the highest yields were obtained from the normal seed rate treated with Ceresan.

Similar trials were carried out with wheat and barley, and while the results were favourable to the treated seed, the differences were not large enough to be considered significant. These experiments are all being repeated this year.

Manuring experiments in the past at Boghall have indicated that no economic response has been received from an application of potassic fertiliser to oats. This finding does not imply that in other districts no response will be got from potash. In view of that finding the manuring policy for that crop has been to apply only nitrogen and phosphates in the form of sulphate of ammonia and superphosphate. Among the range of concentrated fertilisers offered by I.C.I. is one giving the following analysis: N 16 per cent., P_2O_5 32 per cent. The amount of plant food contained in 1 cwt. of this manure is almost equivalent to 3 cwt. of the mixture of ordinary manures usually sown on the farm. For the past two years replicated experiments have been in progress to discover if this smaller quantity of concentrated fertiliser gives as good results as the larger quantity of ordinary fertiliser. Results of the two years taken together indicate that as good a response can be expected from the concentrated fertiliser as from the equivalent amount of ordinary manure.

A small scale observation trial was again carried out to observe the effects of kainit, sodium chloride and potassium chloride on the standing power of oats. The ground was liberally manured with sulphate of ammonia to produce conditions similar to those following an older ley containing wild white clover. As observed in previous years, the salts, applied at the rates of kainit 3 cwt. per acre, sodium 3 cwt. per acre, potassium chloride 1½ cwt. per acre, had a considerable effect in preventing lodging. The check plot receiving none of these salts was badly lodged. The trial is to be repeated under field conditions this season in Fife and Peeblesshire.

The results of the oat variety trial carried out during 1932 were again favourable to Star. The performance of this variety has been commented on in favourable terms in previous reports from Boghall, and its popularity in the College area has grown rapidly in the last three or four years.

Potatoes.—As the suggestion had been made that some of the concentrated fertilisers referred to above might not give their maximum results unless the soil had a neutral or slightly alkaline reaction, a trial was arranged as under.

A piece of ground was selected with a pH of 5·6; one half received an application of lime sufficient to reduce the reaction to neutrality, the other half received no lime. Crosswise to these two treatments, the following applications of fertilisers were given :—

1. No. 2 concentrated fertiliser (analysis, 10·5 per cent. nitrogen, 10·5 per cent. phosphoric acid, 21 per cent. K_2O), at the rate of 5 cwt. an acre.

2. An ordinary compound fertiliser made up to contain the same amount of manurial constituents as the above (the actual application working out to about 8 cwt. an acre).

There were thus four distinct treatments :—

(1) Ordinary manure plus lime.
(2) Ordinary manure with no lime.
(3) Concentrated manure plus lime.
(4) Concentrated manure with no lime.

The area was planted with stock seed Kerr's Pink, and the following yields were obtained per acre :—

(1) 13 tons 9 cwt.	(2) 14 tons 0 cwt.
(3) 13 tons 14 cwt.	(4) 14 tons 4 cwt.

It will be noticed that with both types of fertilisers the advantage lies with the unlimed plots, and that consequently, as far as these results show, no advantage lies in reducing the soil reaction to neutrality when applying these concentrated fertilisers.

Another interesting small-scale experiment was carried out involving the treatment with Agrosan S.B. of potato seed affected with skin diseases such as corky and ordinary scab. Two hundred tubers were selected which were badly affected with the above diseases. One half of the tubers was treated by the dipping method according to the instructions, while the other half was left untreated. About 1800 tubers including chats were harvested from each section, when it was found that 932 tubers from the untreated seed were affected with scabs and only 54 from the treated seed.

An electro colloidal copper spray (Bouisol) for the prevention of blight was used for the first time at the farm during 1932 on a section of stock seed Golden Wonder potatoes. As last potato season proved to be more or less free from blight, no informative results were obtained.

Turnips.—Work has been continued with the trial of new varieties.

The finger and toe problem was the subject of several experiments. The classification of varieties of Swedes and Yellows according to their resistance was continued. The Bruce and a selection of the Bruce again showed their superiority to any other varieties and strains of yellow turnip. On land not badly affected with finger and toe, however, the yield of the Bruce does not compare favourably with the yield of a variety like Victor Achilles. For some years now selection work on a green top strain of the Bruce has been in progress at Boghall, with encouraging results from the point of view of resistance to finger and toe and of yield.

Bangholm (Swede), which has a reputation as a resister, has always been found at Boghall to be in no way superior to some of the more widely grown Swedes.

On the manurial side a mixture of nitrate of soda and basic slag has been found to be far superior to the more usual mixture of sulphate of ammonia and superphosphate (plus in each case potash) from the point of view of resistance to attack by finger and toe.

Seed treatment with formaldehyde and paraffin, and soil treatment with corrosive sublimate, Bordeaux mixture and potassium permanganate have, up till now, given no positive results.

Craibstone

Oats, 1932.—Following the trials carried out last year with Ceresan as a dressing against fungoid diseases which attack grain, a further trial was carried out in 1932 with six different varieties of oats. Half of the seed of each variety was treated with Ceresan about a week before seeding time, the other half being untreated. Sowing, at the rate of 2¾ million seeds per acre, was done on 16th March when the soil was in fair condition, but cold wet weather followed for a few weeks, and this retarded brairding, which took about a month. The weather conditions which retard the growth of the grain are considered suitable for the development of the fungoid diseases.

It was soon quite evident that the treatment had again a beneficial effect, the plants in the treated plots being both more numerous and more luxuriant than in the untreated. The number of plants in several square yards was counted, and in the treated plots they varied from 400 to 500 per square yard, while in the untreated there were only about 250. Further, as showing the average relative vigour of the plants, 100 plants from the treated plots weighed 36 grammes, whereas the same number of plants from the untreated plots weighed only 26 grammes.

In order to obtain information regarding the stage at which the plants in the untreated plot perished, a number of grains from the plot was collected, and these, when examined, showed that the kernels were absolutely black while the embryo appeared to be quite fresh but had not even started to grow. A few plants that did braird died off before they tillered.

The difference in thickness during the season showed more clearly with some varieties than with others. For example, the treated plot of Star, even up to the time of cutting, was thicker and the plants more dwarf than in the untreated plot, where the plot was much thinner but the plants several inches taller.

S.S.P.B. 635 and Victory were slightly laid in patches, but there was little difference in this respect between the treated and untreated parts. The treated plots, however, were generally slightly earlier than the untreated, probably owing to their being rather thicker. After threshing, the following results were obtained:—

	Order of Earliness	TREATED		UNTREATED	
		Grain cwt.	Straw cwt.	Grain cwt.	Straw cwt.
Eagle . .	2	30·3	39·5	29·4	35·8
Elder . .	6	26·6	40·8	24·4	34·4
Star . .	3	27·4	38·8	22·6	31·5
S.S.P.B. 635 .	4	29·2	46·1	26·3	40·7
Victory . .	5	32·3	46·2	30·8	41·7
Yielder . .	1	26·9	35·5	26·8	37·1
Average .	..	28·8	41·7	26·7	36·9

There was some loss of grain during harvesting operations; owing to their being earliest the treated plots of Yielder and Eagle suffered most.

Several other materials were tried in another field, but unfortunately it was not very uniform, so that final results could not be obtained, but the appearance of the plots after brairding showed that such materials as Agrosan, Abavit and yellow oxide of mercury all had a good effect. More extended trials are being carried out this year with these and several other materials.

Small trials on the effect of the quantity of material and the time of treating the seed indicated that, when the treatment is thorough, a smaller quantity than that generally used may give quite good results, and when carried out a considerable time beforehand it was not so successful as when done shortly before seeding. Apparently when the material is used in excess it has a detrimental effect on the seed.

It is possible that these two factors may be inter-related, and that, if a smaller quantity were used, the early treatment might be quite as successful as the later. Several plots have been laid down this year to gain information on these two points.

A question of considerable importance is, "Is one dressing sufficient for several seasons, or has the grain to be dressed every year?" In the above trial, with all the varieties except S.S.P.B. 635 seed from the treated and untreated plots of the 1931 trial was used as follows:—

1. Treated in 1931 and 1932.
2. Treated in 1931 and untreated in 1932.
3. Untreated in 1931 and treated in 1932.
4. Untreated in 1931 and untreated in 1932.

There was no difference in the number of plants or in their vigour between Nos. 1 and 3, nor between Nos. 2 and 4, which indicates that if seed requires treatment it has to be done every year.

Another question is, "If the treatment shows a good effect and the braird is thicker, how far can the seeding be reduced ?" The first point to decide of course is whether the present seeding, apart from the treatment, is the most economic. This is not likely in most cases, as the economic seeding must necessarily depend not only on the kind of soil but also on the season.

Several years ago, twelve varieties of oats were sown with an ordinary broadcast machine. In one side the seeding was thinner than the other, the seedings being about five and seven bushels respectively. During the season it was seen quite distinctly that the thick seedings were shorter and thicker than the thin seedings. In one or two cases the thick side was lying while the thin side was standing. When the crop was weighed there was comparatively little difference either in grain or straw in any of the varieties, indicating that the plants can accommodate themselves to a considerable extent to their conditions.

In another year plots of Potato and Victory were sown at the rates of 2, 3, 4, 5, 6, 7, 8, 9 and 10 bushels per acre respectively, and with the exception of the extremes there was again little difference in the yield.

In 1932 plots of several varieties were sown with treated seed at different thicknesses on two fields, one (Tones), after potatoes, being in good heart, while the other (Sunnybrae), although it was after lea, was in comparatively poor heart. The appearance of the plots was as distinct as in the previous trials. The height of the crop in two plots was measured and was as follows :—

Thin seeding (1½ cwt.)—4 ft. 8 in.
Thick seeding (3 cwt.)—4 ft.

The following weights were obtained :—

TONES	YIELDER		ELDER		PURE LINE		VICTORY	
Seeding per acre.	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
1½ .	30·1	45·9	35·0	56·7	29·0	53·8	39·9	51·4
2 .	29·5	43·6	35·8	53·5	26·8	46·4	39·3	49·6
2½ .	31·1	43·7	35·3	57·8	27·2	48·9	38·6	49·5
3 .	30·4	50·7	32·5	48·1	23·4	40·6	40·1	52·4
SUNNYBRAE							EAGLE	
1½ .	23·2	35·5	23·8	40·0	25·6	41·9	18·5	29·0
2 .	24·2	39·4	23·3	38·2	24·3	45·8	24·2	34·7
2½ .	27·3	37·6	28·1	42·1	23·6	39·9	23·2	31·7
3 .	26·0	38·9	26·4	43·8	22·7	38·1	22·0	29·0

It will be seen generally that, in the case of the large grained varieties of oats, the seeding may apparently vary within comparatively wide limits without having much appreciable effect on the yield. On the poorer soil the thinnest seedings were distinctly too low. In the case of the McGS Pure Line Potato oat, which may be taken to represent the straw varieties, the thick seedings were distinctly too thick on both the good and poor soils.

An effect of the thick seeding was distinctly seen in the Sunnybrae field, where 20 lb. per acre of perennial ryegrass was sown. The amount and vigour of the ryegrass plants were reduced by the thick seedings. Where the seedings were thin the ryegrass was much thicker and more vigorous. Further, it was much better after the early variety Yielder than after the late variety Elder, and it was also better after the large grained varieties than after the McGS Pure Line Potato. It is well known, of course, that in the same way thin seedings tend to encourage weeds should they be present.

Other effects that have been seen in other seasons are that thick seedings tend to be earlier than thin but are more liable to lodge.

Several varieties of oats which had in previous trials stood well were sown in a field after lea with wild white clover. Victory, although it had been found not to stand well, was included as a check. A new variety from Ireland—Stormont Arrow—and a new selection of Potato, which were said to be good standing varieties, were added.

The season was not suitable for a trial of this kind, as there was neither a period of rapid growth nor sufficient heavy rain at the critical period to cause any of the varieties to lodge, so no information on that point was obtained.

Oats—Standing Power Trial, 1932

	Order of Earliness	Per acre	
		Grain cwt.	Straw cwt.
Yielder	1	24·4	30·5
S.S.P.B. 644	2	26·1	34·5
McGS Pure Line	3	21·0	37·1
Marvellous	4	25·0	31·7
R. 30	5	18·4	24·3
New Potato		23·8	39·8
Victory	7	26·3	32·7
Eagle	8	22·4	28·9
Elder	9	26·1	37·7
Stormont Arrow	10	26·0	32·9

It had been observed in previous years that Yielder is very susceptible to dry conditions during the growing season, and it looked at one time as if it were to suffer, but there was sufficient rain to carry it on. Elder, growing alongside, was quite a contrast, as it kept fresh and green and did not show any appearance of suffering. McGS Pure Line and R. 30 were apparently too thick, and this undoubtedly lowered their yield. The Irish variety was very late, but this may have been due to some extent to its being thinner than other varieties, although the rate of seeding was the same.

Many growers are now satisfied that it is an advantage to sow well-graded seed, but so far there has been difficulty in getting this done, as there was no suitable machine for the purpose. It is gratifying, therefore, that agricultural engineers in Aberdeen have now put on the market suitable sizers at comparatively cheap rates. In addition to taking out small grains and weed seeds, these sizers are also able to take out almost all the wild oats that may be present. As showing the necessity for this, it may be mentioned that of 60 ordinary commercial samples of oats examined last spring (1932) no fewer than 35 contained wild oats.

It would be well for buyers to examine samples carefully for wild oats, as although a sample may have a purity of 99·9 per cent., it may contain sufficient seeds of wild oats to sow two per square yard.

A trial was again carried out to demonstrate the value of using graded seed. In one plot ordinary ungraded seed was sown at the rate of 300 lb. per acre, while in another the same quantity of seed was taken and 76 lb. of the small grains sifted out, the remaining 224 lb. being sown. It was again noted that the plants of the first plot were much more irregular in size than in the second. There was no lodging in either plot, but it had been noted previously that the former goes down more readily under adverse weather conditions. The weights obtained were :—

	Per acre Grain cwt.	Per acre Straw cwt.	Weight per bushel lb.
300 lb. Ordinary sample .	22·8	31·6	42
224 ,, Graded ,, .	24·4	32·8	43½

Most growers are now satisfied that the late sowing of oats means a considerable reduction in yield, and there is no doubt but that the many poor crops after turnips are due to late sowing. The following results were obtained last year with Victory oats after turnips :—

	Per acre Grain cwt.	Per acre Straw cwt.	Weight per bushel lb.
Sown 22nd March . .	26·2	36·9	43
,, 19th April . .	21·1	35·5	41

Auchincruive

During the winter of 1932-33 a preliminary sheep-feeding experiment was carried out at Auchincruive, the chief aims in view being to obtain further information as to :

(1) The amount of swedes required by fattening hoggets.
(2) The result of restricting the allowance of swedes and increasing the concentrates.
(3) The practicability of fattening sheep on swedes and hay, without any concentrates.

For the experiment 122 cross-bred lambs (Border Leicester Ram by

Blackface Ewe) were purchased at one of the Lamb Sales at Ayr in the beginning of October. They were run on grass until December, and thereafter 112 were selected and divided into four groups with 28 in each. The groups were made as uniform as possible in all respects, the average live-weight for each being just under 80 lb.

As a precautionary measure the four groups were differently keeled. In addition, the sheep were numbered consecutively by the insertion of a small tag in the ear of each.

They were weighed individually at the commencement and end of the trial on a special weighbridge for very accurate experimental work, and also in groups on the large cattle weighbridge during the progress of the experiment.

The sheep were put on the turnip land after the swedes had been lifted, each group being enclosed in an area of approximately one acre in extent. They were confined to this section during the entire progress of the experiment.

The field was a fairly exposed one, though a hedge on one side afforded a certain amount of shelter for all the groups of sheep.

The ground, though naturally fairly dry, was in view of the heavy rainfall and the tramping of the sheep at times in a pretty wet condition.

The experiment was continued for a period of nine weeks, the daily rations being as follows :

Group I. 16 lb. swedes and an average of 1 lb. of concentrates.
Group II. 12 lb. swedes and an average of 1½ lb. of concentrates.
Group III. 8 lb. swedes and an average of just under 2 lb. of concentrates.
Group IV. 16 lb. swedes, no concentrates, hay *ad lib.*

The concentrates fed consisted of a mixture of :

2 parts crushed oats.
1 part bran.
1 ,, decorticated cotton seed meal.

One-half of the daily allowance was given at 8 a.m. and the other half at 4 p.m.. The swedes were cut and fed in boxes in the usual way and given after the concentrates.

No change was made in the daily allowance of swedes, but the concentrate rations were increased at the rate of 1 oz. per sheep per week. For example, that for Group I commenced at 12 oz. and increased by 1 oz. weekly to 20 oz., giving an average of 1 lb. for the nine-week feeding period. In the same way, that for Group II commenced at 20 oz. and increased to 28 oz. Group III commenced with 28 oz. but were not increased to 36 oz. as the maximum they were able to consume was 34 oz. The average for this group was accordingly a little under 2 lb. per day.

The hay for Group IV was not chaffed but was fed as long hay, and though the sheep had free access to it at all times the amount taken averaged just a little over ½ lb. per sheep per day.

The live-weights at the beginning and end of the experiment and the increases for the entire period are given below :

		Average Live-weight		Live-weight
		Start	Finish	Increase
Group	Daily Ration	lb.	lb.	lb.
I.	16 lb. swedes . 1 lb. concentrates	79¾	92¾	13
II.	12 lb. swedes . 1½ lb. concentrates	79¾	95¾	16
III.	8 lb. swedes . 2 lb. concentrates	79¾	96	16¼
IV.	16 lb. swedes . No concentrates . hay *ad lib.* . .	79¾	90¾	11

Taking the swedes at 8d. per cwt. (13s. 4d. per ton), the concentrates at £6, 13s. 4d., and the hay at 40s. per ton, the cost of the rations per sheep per week are as follows :

Group I, 1s. 1d. ; Group II, 1s. 1½d. ; Group III, 1s. 2d. ; Group IV, 8¾d.

On the conclusion of the trial the majority of the hoggets were in very good condition. Twenty were selected from each of Groups I, II, and III, but only 10 of the 28 comprising Group IV were found to be in equally good condition, as their progress had been slower. The sheep were marketed in Glasgow in their respective groups, 35 being put into one sale ring and 35 in another.

The prices realised were as follows :

	s.	d.
Group I. Average for 20 sheep	43	1½
Group II. ,, ,, ,, ...	43	9
Group III. ,, ,, ,, ...	46	0
Group IV. Average for 10 ,, ...	41	4½

The buyers of the different groups of sheep very kindly furnished the College with the carcass weights of the lots purchased—those were as follows :

	lb.
Group I. Average for 20 sheep	42·25
Group II. ,, ,, ,, ...	44·40
Group III. ,, ,, ,, ...	46·36
Group IV. Average for 10 ,, ...	39·35

Financial Aspect.—Though all of the sheep were not ready for market at the time the experiment concluded, nevertheless, the return for those sold gives some indication as to the ration which gave the best result.

The purchase price of the lambs in the first week in October was 21s. 3d., and the value at the time the experiment started might be put at 25s. ; since to the inbuying price there falls to be added grazing for 8 weeks at 4d. a week and a daily allowance of ½ lb. trough food at 6s. 8d. a cwt. for the last four weeks on pasture.

The balance, after deducting the cost of the rations for the nine weeks on swedes, etc., is as follows :

	s.	d.
Group I. Balance for 20 sheep . . .	8	1½
Group II. ,, ,, ,, . . .	8	7½
Group III. ,, ,, ,, . . .	10	6
Group IV. Balance for 10 ,, . . .	10	0

These margins are, of course, after having charged the swedes consumed at 13s. 4d. per ton, and they therefore represent a substantial profit.

This preliminary trial would appear to indicate that where rapid fattening is the aim in view, restricting the root ration and increasing the concentrate ration is likely to give the best result, not only in live-weight increase and carcass weight, but also as regards monetary return. Further, the point should not be overlooked that a daily allowance of 8 lb. swedes as against 16 lb. would permit of double the number of sheep being fattened on the same acreage of roots.

On the other hand, if it is desired to bring the flock on slowly for sale later in the year, swedes and hay constitute a very cheap ration for the purpose.

The investigators have been rather impressed by the fact that none of the groups of sheep were able to take the amount of Total Dry Matter indicated in "Rations for Live-stock," Bulletin No. 48, Ministry of Agriculture and Fisheries, as appropriate amounts for sheep of corresponding weights, and they are in consequence inclined to the view that these amounts are rather liberal.

Effects of Manuring on Potato Varieties

FOR some years past experiments have been undertaken in Scotland to determine the effects of manuring on different varieties of the potato. These experiments have been done under the supervision of the Scottish Field Trials Experiment Committee, which co-ordinates field experiments at the Central Institutes, reviews their progress, and suggests likely subjects for experiment and the manner in which these experiments should be conducted and interpreted.

Preliminary trials at the farm of the Edinburgh and East of Scotland College of Agriculture at Boghall in 1926 and 1927 had indicated that under the conditions prevailing at the time, Great Scot responded better to increased applications of artificials than did King Edward. This conclusion was deemed to be of such importance as to justify further investigation of the matter on a larger scale. It was therefore decided to carry out a Response to Manuring experiment during the years 1929 and 1930 at the Department's Experiment Station at East Craigs, at Boghall, and at the North of Scotland College of Agriculture's Farm at Craibstone.

In this experiment the treatments consisted of applications of 6, 8, 10 and 12 cwt. of artificials in addition to the normal applications of dung. Three varieties of potato were used, viz., Great Scot, King Edward, and Golden Wonder. Each treatment was repeated three times with each variety. The size of each plot after eliminating end plants was 0·448 acre. The layout of the plots and the data available rendered possible a statistical analysis of the results in accordance with a method described by F. L. Engledow and C. Udny Yule.

Summary of Results.—The statistical analysis of the trials at East Craigs and Boghall showed that at both centres there had been much variation besides the variation arising from differences in manurial treatment. This additional variation largely obscured the effects due only to the different manurial treatments. The results, however, did show that, generally, Great Scot and Golden Wonder responded better to the heavier applications of manure than did King Edward. In general, Great Scot and Golden Wonder gave significant increases with 12 cwt. of manure, whereas in the case of King Edward the heaviest application to give a significant increase was 10 cwt. The Craibstone results did not confirm the findings at the other two centres, as 10 cwt. was found to be the most productive dressing for both King Edward and Golden Wonder, while 10 to 12 cwt. was best for Great Scot. The statistical significance of the Craibstone results could not be gauged as averages only were available at this centre.

General Notes.—In the conduct of potato trials it is advocated that the following points should be carefully considered. Adequate repetition and scattered distribution of the plots is not inconsistent with a simple layout. It is a definite advantage to be able to subject the results to statistical analysis. At the same time complacent reliance should not be placed on statistical analysis alone for the elimination of inaccurate results. Necessary considerations are that the ground should be carefully chosen, and that constant attention should be devoted to the plots in order to ensure that the growth of the plants is as uninterrupted as possible. The nearer the field conditions approach those of a well-worked garden the more even is growth likely to be. Variation between plots is likely to occur for other reasons that those which are purely cultural and under control, but adequate repetition and distribution will tend to reduce sampling errors arising thereby. Observations should be made throughout the season in order that accidental variations may also be noted and taken into consideration. The undernoted events are among those which it is necessary to note for reference:

1. Dates of planting, first harrowing down of drills, final earthing up and lifting.
2. Weather conditions at and about the times of these operations.

A regular fortnightly review of the weather should also be made.
Any irregularity in the growth of any plot.
Date of incidence of blight on any plot.
Date of any storm or attack of frost which seriously affects any plot.

As regards points 3, 4, and 5 the reference number of each plot affected should be recorded.

The Optimum Size of Seed Potatoes

THE following article is contributed by Messrs J. C. Wallace and J. K. Thompson of the Kirton Agricultural Institute:—

The size of tubers used for "seed" purposes tends in practice to vary somewhat according to the condition of the potato market. If the demand for ware is good, there is a tendency—unless seed is correspondingly dear—to dress ware over a smaller riddle. When ware is only in moderate demand a larger riddle is used, thus increasing the maximum size of the seed. If seed is in strong demand, there is a tendency to pass the chats through a smaller riddle, and there may also be a demand for chats for seed purposes. In most seasons Scotch-grown seed tends to be larger than English-grown seed.

Normally, "seed" of early varieties of potatoes is larger than seed of main-crop varieties. The minimum riddle for all classes of English-grown seed is usually 1¼", whilst the maximum size of riddle for earlies may be 2¼", for second earlies is usually 2", and for main-crop 2" to 1¾".

The question of the optimum size of seed potatoes is one of much practical importance. Apart from the question of yield, that of cost per acre is pertinent, especially in those districts where cutting of seed tubers is not practicable. The question has been investigated by Salaman in England, and by Profeit and Findlay in Scotland. The results obtained by these workers agree in indicating that normally the greatest net returns are obtained by the use of medium-sized whole tubers, weighing about 2 ozs.—size approximating to that obtained by passing through a 1¾" riddle. In practice, however, it is impossible either to obtain or to use on a commercial scale seed approximating to 2 ozs. in weight, or 1¾" in size. It is, therefore, desirable to know from within what limits of size good results can be obtained.

In order to obtain this information, experiments were commenced in 1928, and continued over four successive seasons. The variety of potato used was King Edward VII, and the seed was dressed over commercial riddles, thus approximating to material as it would be obtained for ordinary farm purposes. The sizes of seed used were 1¼" over 1", 1½" over 1¼", 1¾" over 1½", 2" over 1¾", 2¼" over 2", 2¼" over 2" cut once, 2½" over 2¼". The various sizes were obtained by passing the tubers through the larger-sized riddles and retaining those which remained in the smaller-sized one. In the first two seasons only single plots of each size were planted, the size of the plots being ⅛ of an acre. In 1930 duplicate plots were planted, and in 1931 the plots were in triplicate. In each season the complete trial was planted on the same day. The sets were evenly spaced at 16 inches apart in the rows. The "cut" seed used for comparison did not perhaps receive fair treatment, as cutting took place at the time of planting, and the cut surface was not treated in any way. All seed was planted unchitted. Once-grown seed was used in 1928 and 1930, twice-grown in 1929 and in 1931.

Observations during the Growing Period.—1928.—Throughout this season the growth of the plot planted with tubers 2½″ over 2¼″ (large ware) was outstanding. From the first the growth was strong and vigorous and of good appearance, but this plot was the first to die down in the autumn. The plot which showed the poorest appearance was that planted with chats, *i.e.* 1¼″ over 1″ size. This plot improved somewhat as the season advanced, and it held out longer than the other plots. Between these two plots, *i.e.* the plots planted with 1¼″ over 1″, and that planted with 2½″ over 2¼″ seed, there was a gradual and definite improvement in appearance of the growing plants with each increase in the size of seed planted, except in the case of cut seed.

The growth of the plot planted with cut seed (2¼″ over 2″ seed cut once) was not equal in appearance to that of the plots planted with whole seed of the same size (*i.e.* 2¼″ over 2″), and was inferior to that of the plot planted with seed of a smaller size (*i.e.* 2″ over 1¾″). The growth was uneven and generally lacked in development. The first plot to die down in the autumn was that planted with the largest seed, followed by the next sized seed, and so on to the plot planted with the smallest seed, which died down last.

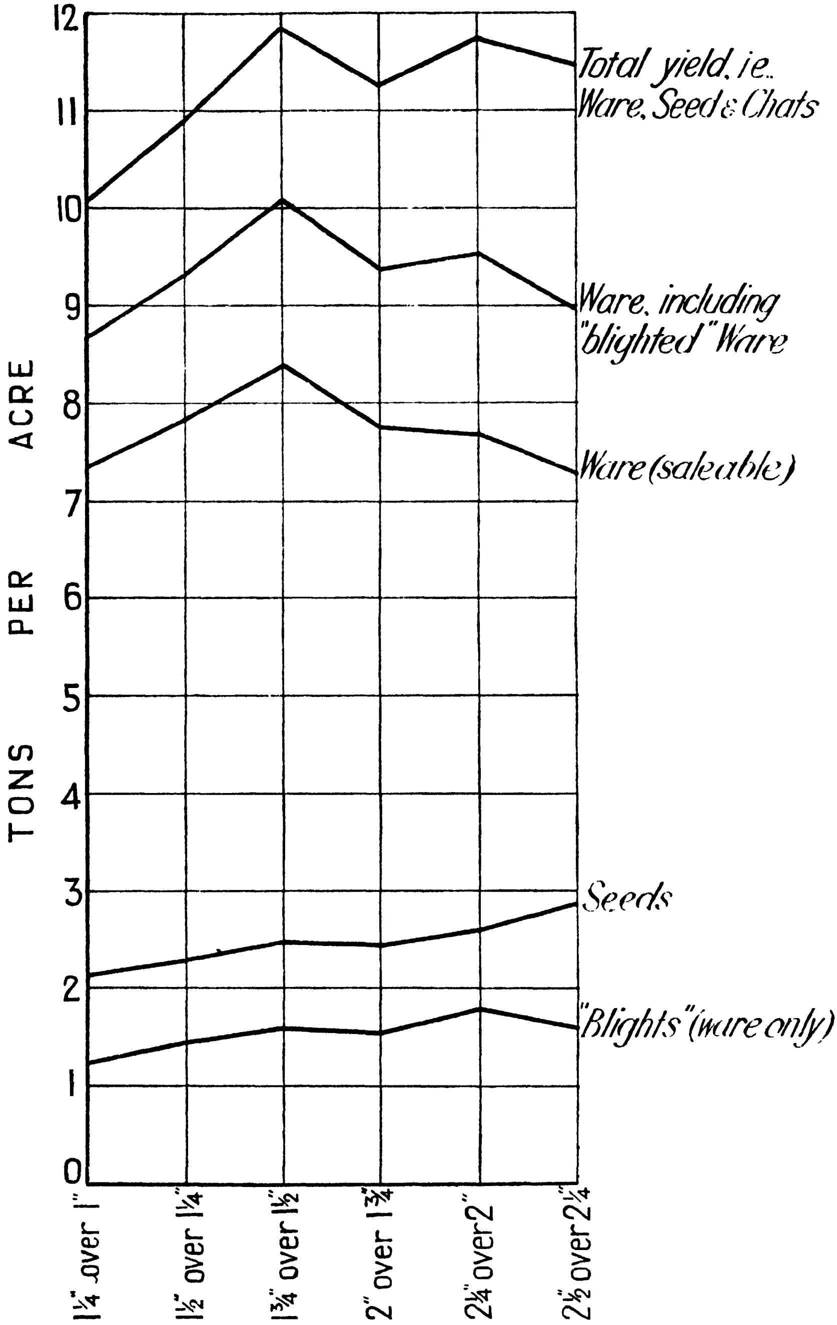
Virus diseases were noted to be more prevalent and intense on the plots planted with the smaller sizes of seed than on those planted with the larger sizes. Ware-sized seed, 2½″ over 2¼″, showed much the least virus infection.

1929.—The general position relative to growth and appearance was similar to that noted in 1928. The plots again "finished" in the same order. The plot planted with cut seed was better in appearance than in 1928, but was still lacking in development.

More virus-infected plants were noted, but this was to be expected, as the "seed" was twice grown. Virus was again more prominent in the plots planted with the smaller sizes of seed. Plants grown from cut seed were more highly infected than those from whole seed of the same size (*i.e.* 2¼″ over 2″, cut and whole). This plot was noted to be the most highly infected of the series.

1930.—The plots were in duplicate. In appearance they differed according to the size of seed used, as in previous years. The differences in maturity were not so marked. Virus disease was not

GRAPH SHOWING AVERAGE RESULTS



prevalent, and little difference was noted between the plots. The seed was once grown, obtained from a very good stock bought from Scotland in the previous year. Unfortunately the experiments had to be planted on very poor land.

1931.—The plots were planted in triplicate, and the positions were randomised. In view of the comparative failure of cut seed in the previous years, it was not included. The differences between the growth of the various plots were similar to those of previous years.

Virus disease was much more prevalent and all plots appeared uniform as regards infection. *Twice-grown seed was used*, and this no doubt accounted for the prevalence of virus disease.

A serious attack of blight was experienced, which destroyed growth on all the plots some considerable time in advance of normal maturity. Blight attack was noted to be much more severe on plots carrying a stronger top, *i.e.* on plots planted with larger seed, the attack being more or less progressive in intensity as the size of seed increased.

The yield was greatly reduced, not only by "blight," but by serious flooding on 6th August, when almost 6 inches of rain fell in twenty-four hours—most of it between mid-day and 4 p.m. The water lay on the land for several days.

Results.—The following tables show the average yield of saleable ware obtained during each year of the experiment, and the graphs show the average total yields, yields of seed and "blights."

Ware Yields (Averages)

	1928				1929				1930				1931			
Inches	T.	c.	q.	lb.	T.	c.	q.	lb.	T.	c.	q.	lb.	T.	c.	q.	lb.
1¼×1 . .	11	11	0	10	8	9	1	20	6	14	1	4	2	14	3	10
1½×1¼ . .	12	6	1	3	9	0	0	0	6	5	2	24	3	12	1	17
1¾×1½ . .	13	8	0	3	9	0	0	0	6	19	3	4	4	2	3	26
2 ×1¾ . .	12	3	2	18	8	15	1	4	6	10	0	0	3	11	3	1
2¼×2 . .	11	17	2	0	8	8	0	0	6	14	3	12	3	18	0	16
2¼×2 (cut) .	11	2	2	5	7	5	0	0		..				..		
2½×2¼ . .	11	17	0	27	7	18	2	8	6	3	2	16	3	3	3	24

Average over Four Years.

Inches	T.	c.	q.	lb.
1¼ × 1 . . .	7	7	1	18
1½ × 1¼ . . .	7	16	0	11
1¾ × 1½ . . .	8	7	2	22
2 × 1¾ . . .	7	15	0	20
2¼ × 2 . . .	7	14	2	14
2½ × 2¼ . . .	7	5	3	12

Notes on the Results.—The highest average yield of both total crop and of ware of the four seasons was produced by seed dressed 1¾″ over 1½″. The lowest average yield was produced by seed dressed

1¼″ over 1″. It will be observed from the accompanying graph that there is a very definite rise in yield up to seed dressed 1¾″ over 1½″, but beyond this point the yield of ware drops rapidly, and when blighted tubers are omitted the yield from the largest size, *i.e.* 2½″ over 2¼″, is slightly less than that produced by the smallest size of seed. It may be noted that the larger sizes of seed produced more blight—in fact there is a very general increase in the weight of blighted tubers as the size of seed is increased. The early attack of blight in 1930 considerably levelled up the yields from the various plots.

A better idea of the position is obtained if the figures are converted into £ s. d. In the following table, which shows the returns per acre obtained from the disposal of ware only, ware has been valued at £5 per ton.

	1928			1929			1930			1931		
Inches	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1¼ × 1	57	15	0	42	5	0	33	10	0	13	15	0
1½ × 1¼	61	10	0	45	0	0	31	10	0	18	0	0
1¾ × 1½	67	0	0	45	0	0	35	0	0	20	15	0
2 × 1¾	61	0	0	43	15	0	32	10	0	18	0	0
2¼ × 2	59	5	0	42	0	0	33	15	0	19	10	0
2½ × 2¼	59	5	0	39	15	0	31	0	0	16	0	0
2¼ × 2 (cut)	55	15	0	36	5	0	..			..		

Average Return of Four Seasons

Inches	£	s.	d.
1¼ × 1	36	16	0
1½ × 1¼	39	0	0
1¾ × 1½	41	18	0
2 × 1¾	38	16	0
2¼ × 2	38	12	0
2½ × 2¼	36	10	0

These figures bear out the general position as shown by the yield results. The maximum return in each season is obtained from seed dressed 1¾″ over 1½″, but whilst the smaller sizes are improved in their comparative position, the largest "seed" shows to greater disadvantage than the yield results alone would lead one to expect. If the cost of seed is taken into account, the larger sizes of seed would show to even greater disadvantage, as the weight of seed, and consequently the cost of seed per acre, would increase with each increase in the size of the seed.

In some districts in England once-grown seed is readily disposed of, usually into other areas, and it may be advisable to consider total returns per acre where the seed is sold at, say, £4 per ton, and ware at £5 per ton.

Average returns of ware only and ware and seed combined:—

	Ware only			Ware and Seed		
Inches	£	s.	d.	£	s.	d.
1¼ × 1	36	16	0	41	8	10
1½ × 1¼	39	0	0	44	2	4
1¾ × 1½	41	18	0	47	13	7
2 × 1¾	38	16	0	44	10	3
2¼ × 2	38	12	0	45	18	7
2½ × 2¼	36	10	0	44	7	11

The highest return is again obtained from seed dressed 1¾″ over 1½″. The smallest size of seed shows up badly, but there is very little difference between any of the others.

Conclusions.—The results are similar to those obtained by Salaman and Profeit and Findlay. The highest yield of ware is obtained from seed dressed 1¾″ over 1½″.

The yield of "seed" increases as the size of seed planted is increased.

In districts where seed cannot be disposed of, the range of seed size for planting should be through a 1¾″ riddle over a 1¼″ riddle.

Where "seed" can be disposed of, somewhat larger sizes of seed may be planted.

The use of cut sets (or seed) is not to be recommended in the district in which the experiments were carried out.

Review

The Industrial Revolution in Scotland. Henry Hamilton, M.A., D.Litt. Oxford-Clarendon Press.

The purpose of this book is to trace the evolution of Scottish economic life from the old-world simplicity that characterised it up to the time of the Union of the Parliaments to the industrial and commercial complex of to-day. The changes that brought this about occurred in the eighteenth and nineteenth centuries, and the stages described are first, a primitive agriculture with a closely related simple type of industry interwoven with it; second, a progressive agriculture and a textile industry still intermixed but passing into the factory phase; and third, the changed conditions brought about by the opening up of the coal and iron fields and the centralising of manufacturing industry.

Beginning with a striking description of the country at the time of the Union, the writer traces the expansion of Scottish commerce and the consequent development of industry which followed the opening of the English and colonial markets to Scottish traders.

The rise and fall of the Glasgow colonial trade; the varying fortunes of the efforts to encourage and maintain the linen industry throughout the country; the spectacular growth of the cotton manufacture and the change over from hand to power loom; the application of coal to the smelting of iron and the remarkable development of iron and steel industries, especially shipbuilding and engineering; the wonderful improvement in means of communication and transport by the making of roads, canals, and railways; all these are detailed and described in masterly fashion, and make up a story of enthralling interest.

To complete the picture an account is given of the beginnings of Scottish banking and of its development into the highly efficient helpmeet of industry and commerce which it has become.

It is obvious that the book is the outcome of wide reading and careful consultation of first-hand authorities, and it is certain to take rank as a reliable work of reference.

To those who are interested in the history of Scottish agriculture the first three chapters will make a special appeal. They give a vivid description of the kind of farming that prevailed throughout the country till the end of the eighteenth century or later, and of the gradual improvement which changed the old-fashioned two-field husbandry to the modern rotational system, with its accompanying advancement in implements and methods of cultivation and in livestock.

Empire Journal of Experimental Agriculture

IT is the opinion of leading agricultural authorities that, without trenching on the ground of existing journals, there is a definite and urgent need of a journal for recording experimental work bearing on the improvement of agriculture throughout the Empire. To meet this need of research workers, education authorities, and progressive farmers, the Oxford University Press will publish in April the first number of the *Empire Journal of Experimental Agriculture*. The new Journal will offer agricultural research workers a medium for disseminating throughout the British Empire the records and results of their investigations on the feeding and management of live-stock, cultivation and manuring of crops, trials of farm machinery, agricultural economics, and experimental technique.

The Journal will command a strong Editorial Board, including, among others, Sir John Russell, Director of the Rothamsted Experimental Station, as Chairman, Sir Rowland Biffen, Sir Daniel Hall, Sir Robert Greig, Sir Frederick Keeble, and leading agricultural authorities in the chief countries of the Empire. Dr E. H. Tripp, 40 Trewsbury Road, Sydenham, London, S.E.26, is Secretary and General Editor.

The Journal will be published quarterly. Subscription price 20s. for four numbers. Single numbers 7s. 6d. net each.

Agricultural Conditions

FROST occurred occasionally during the first week of December, but throughout the greater part of the month mild and open weather prevailed in all parts of Scotland. In the north fine, dry conditions were more or less general through the whole month, and all kinds of outdoor work on farms proceeded with very few delays. In the southern half of the country, however, the weather during the last three weeks of December and the first two weeks of January was unsettled and at times very wet and stormy. In this area all seasonal work was delayed. During the second half of January wintry weather, with keen frosts and occasional snow showers, occurred practically all over the country. The hard conditions during this period stopped cultivation, but farmers were then afforded an opportunity to empty their rather overloaded dung courts and cart manure to their fields. During the first half of February mild but unsettled, and at times boisterous, weather prevailed in the west and south-west, while cold and rather frosty conditions were general in the north and east. In the third week the frosty conditions spread to all districts. Seasonal work on farms made fair progress during the early part of February, the cultivation of the soil and carting of manure being carried on when opportunities occurred; in Berwick and north-east Fife ploughing proceeded for a time under very satisfactory circumstances, when the land was turned over in remarkably fine condition. During the last week of the month, however, the weather was extremely wintry, and, as a consequence of heavy falls of snow, outdoor work everywhere was completely brought to a standstill.

Advantage was taken of the short spells of dry weather in December and January to complete the sowing of wheat on land used last year for root crops. Winter sowings were more extensive than for several years, and, from the estimates furnished by the Department's Crop Reporters at the end of January, it then seemed probable that there would be an increase of about 18,000 acres in the total area under the crop as compared with last year. The area last year was 52,072 acres. Before growth was checked by frost towards the end of January the braird of early-sown wheat had a remarkably fresh and robust appearance, but the wintry weather that occurred during the second half of that month, and again at the end of February, caused a certain amount of damage to the young plants by discoloration, while the cold conditions on each occasion completely checked the growth of the crop for several days.

The reports on potato stocks furnished at the end of January were generally good. Some sprouting occurred in the pits before the weather hardened, while in eastern districts, where a part of the crop was harvested in a rather dirty and wet condition, some loss was occasioned by rotting. Speaking generally, however, maincrop varieties were found to be free from disease, and very few of the tubers were rejected when the crop was dressed. The Department issued to all growers who had an acre or more of potatoes in 1932 an inquiry as to the stocks sold and on hand at 4th February.

The open weather at the close of the year 1932 was of considerable value to flockmasters, and put a satisfactory bloom on both hill and low-ground sheep. The flocks began the winter in thriving condition, and at the end of December hill ewes in Sutherland were said to be faring better than they had done at that date for several years. Hand feeding was necessitated by the severe weather that occurred during the last ten days of January, and again towards the end of February, but the stocks did well, and at the beginning of March there was good reason for expecting a successful lambing season. At that time, however, in the northern counties, the Borders and some of the western islands, the condition of the ewes was not very good, and in these districts fears were entertained that the results of the snowstorms experienced during February may be seen in a diminished crop of lambs. In a few early districts on low ground lambing began early in February. The fall of lambs was generally said to be satisfactory, but the numbers were rather too small for forming a reliable estimate of the crop. Where lambing had begun the weather conditions during the last week of February were particularly difficult for shepherds, and occasioned them much hard work.

Many farmers prefer to lift turnips as they are required, and keep only a small quantity in store to tide over a period of bad weather. Where the crop was thus left out in the fields, it continued to grow throughout December. During January and February, however, frosts were sufficiently keen at times to damage a considerable proportion of the roots, and at the beginning of March it seemed probable that before long the supplies would run short. Ample supplies of good hay and straw were available in all parts of the country, and reports stated that surplus and unsaleable potatoes were being used largely for the feeding of stock.

In all parts of the country agricultural workers were sufficient for requirements, except in the south-west, where the shortage of female dairy hands continued. In several areas unemployment among male workers had increased, but, so far as could be ascertained, the surplus of trained men generally appeared to be comparatively small, and extended to about 5 per cent. or less of the regular workers. Reports indicated that in several districts, both arable and pastoral, practically all the regular workers secured engagements at the Martinmas term hirings.

SCIENCE AND PRACTICE

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS

Trials with Pedigree Strains of Herbage Grasses. *R. G. Stapledon, M.A., and W. E. J. Milton, N.D.A., Series H, No.* 13, *Seasons* 1926-1931, *Welsh Plant Breeding Station, Aberystwyth.*—The investigations were conducted wholly on pure-species plots, with the object of comparing and contrasting pedigree strains of grass species produced at the Station with those derived from the ordinary seed of commerce, and of acquiring information relative to factors influencing the rational management of pastures.

Closely allied indigenous strains of one and the same species (*e.g.* of cocksfoot, timothy, and perennial rye-grass) were found to differ in palatability and as to amount of leaf eaten. The species and strains varied greatly in their yielding ability in relation to intensity of grazing. All strains of cocksfoot yielded heavily under a lenient system of grazing, while the heavier the grazing the greater the contrasting advantage in favour of the indigenous strains. The indigenous strains of perennial rye-grass maintained high-yielding ability under more intensive grazing better than did any of the strains of the other larger grasses. Golden oat-grass and tall oat-grass were unable to persist even under a lenient system of regularised grazing.

Palatability was influenced by a variety of factors, and was also affected by a number of inherent properties of the plants. Red fescue and bent were palatable when permitted only a very short growing period. The leafage of Italian rye-grass and timothy was of an unusually high palatability. Perennial rye-grass and white clover remained palatable in proportion as the leafage aged, to a greater degree than did other species. Strains which were not grazed hard were liable to persist and to remain productive for a number of years. The high and sustained productivity of indigenous red fescue was probably in large measure due to the fact that it was not grazed as hard as other strains. All species and strains gave considerably more spring keep after hay *cum* aftermath than after pasture.

Indigenous meadow foxtail and indigenous cocksfoot give a very leafy herbage in pasture and aftermath, while meadow foxtail gives an exceptionally leafy hay. At the other extreme were plants like Italian rye-grass, Golden oat-grass, Yorkshire fog. Golden oat-grass was the only species of which the sheep ate practically as much stem as leaf.

It could be asserted that no two species or strains of grass would react in precisely the same way to any single factor that influences seasonal productivity, persistence, palatability, or any other property of a sward that affects its economic value. The answer to the question of how to manage grassland scientifically would seem to lie in a simplification of the botanical composition of swards.

Insect Transmission of Dry-Rot (Phoma lingam) of Swedes. *W. Cottier, New Zealand Journal of Agriculture. Volume* 45, *No.* 4, *October* 1932.—The conclusion is reached that the disease was carried from the diseased bulbs to healthy ones by the insects introduced into the box cages. It was found that dry-rot was transmitted much more freely among the chipped than among the undamaged bulbs. This demonstrates the importance of avoiding, as far as possible, injury to swedes during cultivation, etc.

The experiment showed that dry-rot of swedes can be carried by insects, particularly to injured bulbs.

SOILS

Cement in Moor Soils. *Br. Tacke. Jahrbuch der Moorkunde,* 1931, *18*, 3-6.—The increasing use of cement in building materials has brought into prominence the disadvantages which exist when this substance is used in moor soils. The compounds present in moorland having a harmful effect on cement are considered to be:

1. Free acids, *e.g.* sulphuric, carbonic, and organic acids, and sulphide of hydrogen.
2. Salts, *e.g.* sulphate of calcium and sulphide of iron.
3. The comparatively pure water draining from moorland poor in mineral matter.

The much greater destructive power of running as compared with stagnant water is emphasised. Protective measures are discussed.

The Influence of the Soil on the Value of Seed Potatoes. *Fr. Brüne. Jahrbuch der Moorkunde*, 1931, *18*, 7-13.—To determine the effect of soil conditions on the value of potatoes used for seed purposes, a series of experiments was carried out on a heavy alluvial clay, a sand, and a moss soil, the seed used in each case being taken from all three types. It was found that the seed from a clay soil gave the highest, while that from a sandy soil gave the lowest yields when grown on clay and moss soils. On the sandy soil seed from clay and moss soils gave slightly lower yields than those from a sandy soil.

Manuring of Meadow Hay Land. *W. A. Jacques. Jour. Agric. Sci.*, 1933, *23*, 146-160.—In 1899 a series of plots was laid down in Yorkshire to compare the effects of dung and artificial manures on the yield and botanical composition of meadow hay. The results up to 1911 showed that dung plots gave higher yields than those treated with artificial manures. Nitrate of soda produced heavier crops than sulphate of ammonia. In 1911 the north halves of the plots received slaked lime at the rate of 3 tons quicklime per acre, and in 1922 a further addition of 3 tons quicklime per acre, as waste carbonate of lime, was given. In the period 1912-1927 the dunged plots still gave greater yields than those treated with artificial manures, and nitrate of soda again proved superior to sulphate of ammonia, and except in two cases where the plots had received dung the yields were greater from the limed areas.

In all cases nitrate of soda produced better herbage than sulphate of ammonia, with and without lime. Complete manuring proved better than incomplete manuring, but the best hay was obtained from the dunged plots where the growth of cocksfoot and rough-stalked meadow grass was encouraged. With complete artificial manuring sheep's and hard fescues, sweet vernal and bent grass took the place of cocksfoot.

Influence of Phosphoric Acid Manuring on the Yield and Quality of Malting Barley. *C. Krugel, C. Dreyspring, and H. Kurth. Superphosphate*, 1932, *5*. 229-243.—The addition of superphosphate to a soil in which barley was grown considerably increased yield and quality of the crop. The main advantages of such treatment were increase of proportion of grain to straw, increase in size, weight, and number of grains, decrease in albumen, and increase in starch content of the grain.

The Effects Produced by the Three Main Plant Foods in Light of Prolonged Field Experiments. *Clausen. Die Ernährung der Pflanze*, 1932, *22*, 397-399.—Numerous experiments carried out on plots treated as follows: (1) Complete manure of nitrogen, phosphate, and potash, (2) potash and phosphate, (3) nitrogen and potash, (4) nitrogen and phosphate, (5) no manure, have shown the effects of complete manuring and of individual manuring with nitrogen, potash, and phosphate on various crops. It it is assumed that the sum of the individual effects of the three nutrients is unity, then the total effect of a complete manure is found to be 0·684 with rye, 0·799 with oats, 0·798 with potatoes, 0·650 with clover-grass mixture. Potatoes have a very high potash requirement, much higher than for grain crops. Where potash was omitted, decreased yields were obtained, even where a large excess of nitrogen and phosphate was present.

The Effect of Potash Manuring on the Structure and Mechanical Properties of Barley Straw. *W. Acker. Die Ernährung der Pflanze*, 1932, *22*, 401-403.—Additions of potash to barley promote the development of the mechanical properties of that plant, and even in the early stages of growth strengthen the structure so as to enable the plant to withstand drought and the attack of pests.

Fundamental Investigations into the Relationship between Results of the Neubauer and Aspergillus[1] Methods.—*H. Niklas and M. Miller. Die Ernährung der Pflanze*, 1932, *23*, 417-420.—Mathematical treatment of results has shown that a close relationship exists between the potash deficiencies of soils as determined by the Neubauer and Aspergillus methods. Since the latter is the cheaper and easier to carry out, it is suggested that it should replace the former.

The Importance of Potash Manuring in Vegetable Growing. *A. Gehring. Die Ernährung der Pflanze*, 1933, *29*, 21-23.—A loamy sand was dunged (16 tons per acre) in autumn 1930, and treated in spring 1931 with 36 lb. nitrogen per acre as "Montan saltpeter," and 54 lb. per acre phosphoric acid as basic slag. Potash was applied at the rates of 67 lb., 134 lb., and 201 lb. per acre as muriate. The first and second crops, beans and winter savoy, showed no response. In 1932 the field was again dressed with 72 lb. nitrogen and 54 lb. phosphoric acid, and 34 lb., 68 lb., and 102 lb. potash per acre. All the plots treated with potash showed substantial increases in yield over those receiving no potash.

[1] For details of this method see article entitled "Available Plant Food in Soils," by A. M. Smith, B.Sc. Ph.D., and R. Coull, B.Sc. *Scot. Jour. of Agric.*, Vol. xv, No. 3, p. 262.

With the dressing of 68 lb. potash per acre increases over the " no potash " plots of 1 ton 3½ cwt., 8½ cwt., and 2 tons 11½ cwt. per acre were obtained for carrots, kohl rabi, and celery respectively.

The Available Supply of Soil Water and Nutrients to the Plant. *F. Sekera. Die Ernährung der Pflanze,* 1933, *29,* 61-70.—Of the total amount of water which a soil can contain (water-holding capacity), a certain portion is combined in the soil particles and cannot be used by the plant. The remaining fraction of uncombined or " available " water can be absorbed by the plant, and will be determined by the magnitude of the water-holding capacity and content of combined water of the soil. The supply of nutrients to the plant takes place with the absorption of the available water. It follows that in a dry year symptoms of drought and starvation will be more evident in soils having a high content of combined water. Calcium salts decrease and sodium salts increase the amount of combined water in a soil.

Soil Reaction of Phosphoric Acid Solubility as Affected by Repeated Applications of Potash. *A. Frey. Die Ernährung der Pflanze,* 1933, *29,* 71-74.—Experiments carried out since 1913 show that potash manuring may bring about a slight increase or decrease in soil reaction depending on soil type. With muriate of potash or potash manure salts the effect was less than with kainit or sulphate of potash. A partial conversion of total phosphoric acid into " available " phosphoric acid was noted, especially in the case of muriate of potash. Potash manure salts, sulphate of potash and kainit, also brought about this conversion, but to a lesser degree.

The Movement of Phosphoric Acid in the Soil. *S. Gericke. Zeit. Pflanz. Dung. u. Bodenkunde,* 1932, *Bd.* 27, *Helt* 3/4.—Experiments were carried out with different phosphates on three different soil types, viz., (1) A neutral loamy sand, (2) an acid sandy soil, and (3) a heavy alkaline loam. The soils were filled into lead pots with perforated bases, which were sunk into the ground and left for sixteen months : each series of pots received equivalent dressings of phosphoric acid as superphosphate, basic slag, and Rhenania phosphate respectively. The important influences of soil type, degree of acidity, form in which phosphate is applied, etc., on the distribution and mobility of the phosphoric acid in the soil are discussed. It is shown that in practice there is little danger of phosphoric acid being washed away in the drainage water.

A Review of Researches on Nitrogen Fertilisation in Relation to Economic Crop Production, with Special Reference to Future Investigations. *W. P. Kelley. Jour. Amer. Soc. Agron.,* 1933, *Volume* 25, *No.* 1.—Points such as the following are discussed briefly: The effects of different nitrogenous fertilisers on yield and quality of crops and on the soil: nitrogen gains and losses from soils: the relation of nitrogen to other elements, and the value of local field experiments as a means of ascertaining the nitrogen requirements of a given soil and crop. Stress is laid on the need for much additional research on nitrogen fertilisation.

Relations between the Reaction of the Soil and its Content of Root Soluble Phosphoric Acid and Potash. *Kling and Engels. Zeit. Pflanz. Dung. u. Bodenkunde,* 1933, 12, 1*B.*—An account is given of some of the literature on the subject, and the results of further experiments are outlined. The more acid the soil the greater is the likelihood of deficiencies in both potash and phosphate. Neutral and alkaline soils are less frequently deficient in potash. As acidity decreases, the number of soils showing phosphate deficiency decreases until the neutral point is passed, but the number increases again in alkaline soils.

Phosphoric Acid in the Soil. *M. Odelien. Tidskr. for det norske Landbruk,* 1932, *39,* 203.—A general account is given of the behaviour of phosphoric acid in the soil. It is shown, for instance, that of the total soil phosphate anything from 15 to 50 per cent. may be present in organic compounds. The extent to which phosphoric acid is bound in the soil depends on the soil type, but it is only in uncultivated soils containing acid humus that phosphoric acid is leached out to any appreciable extent. The relative values as plant foods of various phosphatic fertilisers and their behaviour in the soil are discussed; for instance, phosphoric acid appears to be taken up by plants more easily from mineral phosphatic fertilisers than from dung. Acid soils generally require larger additions of phosphate than neutral ones : this is associated principally with the relative amounts of calcium, aluminium, iron, and magnesium in the soil.

The Influence of Chlorides and Sulphates on the Nitrification of Nitrogenous Manures. *G. Kulik. Düngung und Ernte,* 1931, *3,* 744.—In the presence of chlorides nitrification proceeds more slowly than in the presence of sulphates. It is pointed out that in a comparison of the effects of the sulphates and the chlorides of ammonia and also of potash, this secondary effect may be of considerable importance.

The Behaviour of Sulphur in Field and Pot Experiments. *A. Kalushski. Düngung und Ernte,* 1931, *3,* 718.—Sulphur does not have any influence on the nitrogen supply, but it increases the amount of easily soluble phosphoric acid in the soil.

The Genesis and Development of Two Profiles of a Drift Soil in North-East Scotland. *A. B. Stewart. Jour. Agric. Sci.,* 1933, *Volume* 23, 74.—The results of field and laboratory examination of the various layers in two profiles of a granitic drift soil from Craibstone, Aberdeenshire, are given and discussed. One of the soils was from uncultivated land; the other was taken in adjoining land where the soil is derived from parent material of the same geological origin but is under cultivation. The properties and characteristics of the uncultivated soil are described and compared with those of the cultivated soil. The changes produced by cultivation are pointed out.

DAIRYING

Effects of Metals on Vitamin Content of Milk. *Schieblich. Deut. Nahr. Rundschan, 19,* 150.—When milk is pasteurised in copper, aluminium, and nickel vessels, a small amount of these metals is taken up by the heated milk. Copper destroys Vitamin C, while aluminium has no effect. Nickel is without effect on Vitamins A, B, and C.

Crustless Cheese: Recent Developments. *Pasztor. Chimie et Industrie, 25*(5), 1931.—From Pasztor's researches, it would appear that the moisture content largely determines the degree of hardness, and that a small variation in the humidity can influence the hardness in a remarkable manner. Citric acid, citrates, and disodium phosphate have no outstanding effect on hardness, although it has been noted that phosphates in comparison with citrates produce a rather softer cheese. To produce successive batches of crustless cheese of uniform consistency, the moisture content must be carefully regulated. A moisture content below 40 per cent. produces a crustless product which is firmer than the original cheese (Emmenthal) from which it was made. Approximately the same consistency as the original cheese was realised when the moisture content of the crustless product was from 40 to 43 per cent.

Detection of Mastitis in Milk. *Cherrington, Hansen, and Helversen. Jour. Dairy Sci., 16* (1) 59.—From the public health point of view, it is very desirable to have some means of detecting udder infections by reference to the milk of individual cows or of herds. The authors in this article show that the leucocyte content of milk is the truest indicator of mastitis, and that, using the Breed Smear method, milk from infected udders invariably contains over 100,000 leucocytes per c.c., whereas the milk from normal udders usually contains less than 50,000 leucocytes per c.c. They also found that in respect of bacterial counts blood agar was much more reliable than plain agar for detecting udder infections.

ANIMAL BREEDING

Cattle

A Comparison of the Conformation, Anatomy, and Skeleton of the Cow and Bull of a Dairy Breed. *W. W. Swett, R. R. Graves, and F. W. Miller.* 1932. *Journal of Agricultural Research, Volume* 45, 641-674.—Four years ago the United States Department of Agriculture published an extremely interesting account of the differences between a typical beef cow and a typical dairy cow. Although these cows were found to differ greatly in external form, the differences in weight and size of their internal organs were not sufficient to indicate significant differences in function, and their skeletal structure was similar in most particulars. Except for the extreme differences in external form, the quantity of secretory tissue in their udders was the most striking difference noted. These findings led to the conclusion that the evolution of the dairy and beef types, which has been accomplished through breeding and selection over a period of many years, has not materially altered their skeletal structure, but that the difference in type is due to extreme fleshing on the one hand and to udder development and absence of fleshing on the other. The results of this study suggested the advisability of making a similar comparison of the conformation, anatomy, and skeletal structure of a cow and a bull of the same breed.

For the purpose of this paper a cow and a bull of the Jersey breed were examined. The cow was in fair flesh and weighed 927 lb., while the bull was in good flesh and weighed 1500 lb. Both these weights are typical for the breed. The cow was nineteen years old, and the bull six and a half.

The external conformation of the bull differed considerably from that of the cow. The most marked differences noted were in widths and circumferences of the body and in general heaviness in the anterior parts. In body depths the animals were only moderately different, and in the measurements which indicate "scale" they were almost the same.

The apparent differences in the conformation of the cow and bull are due largely to (1) the "crest" of the bull, which is partly skeletal, but mostly muscular; (2) the low front chest development in the bull, which gets its appearance partly from the heavy muscular development, and partly from the low position of the anterior end of the sternum bone, but largely from the abundance of loose skin that extends from the throat to the brisket; and (3) the fact that the head of the bull, although similar in length and depth to that of the cow, is much broader. Any tendency for the bull to appear light in the flank is due in part to his relatively heavy muscular development in the front quarters, and to the fact that he does not, like the cow, have an udder to carry out his underline on a downward slope.

Although many of the bull's internal organs were actually larger than those of the cow in units of weight or measurement, only two of them were proportionately as large as in the cow when considered on the basis of total animal structure or empty body weight. The differences in size of internal organs do not appear to be sufficiently great to indicate significant differences in functional ability.

In skeletal structure the cow and bull were very similar. The greatest differences appear in the cervical vertebrae, and in the size and shape of the pelvis. The first gives the bull the necessary strength to defend himself; the second is undoubtedly a provision of nature to enable the cow to give birth to her young.

The cow and bull were surprisingly similar in some of their body dimensions, and in their internal anatomy and skeletal structure. The differences which did exist were to a very great extent due to differences in muscular development and fleshing.

The Ayrshire Breed of Cattle: A Genetic Study. *A. B. Fowler.* 1932. *Journal of Dairy Research, Volume* 4, 11-27.—Little, if any, intensive inbreeding has been practised in the creation of the Ayrshire breed of cattle. In order to discover whether there exists any connection between milk yield and inbreeding, the ancestry of three groups of pedigreed cows was examined. These were as follows:

One, recorded cows giving over 1000 gallons. Two, recorded cows giving under 800 gallons (but giving the minimum requirement for entry, which is, for a cow, 2800 gallons at 1 per cent., equivalent to 700 gallons at 4 per cent.). Three, cows selected at random from the breed, irrespective of milk yield. It was found that there was only a slight difference between the first two of these groups, where practically no inbreeding had occurred. The average cows, Group Three, however, showed an appreciable degree of inbreeding. This is in agreement with other studies of this nature.

The paper also includes an interesting historical review of the breed. The recurrence of animals from the Drumjoan herd was remarkable. The first bull to have an effective influence on the breed was Burnhouses, bred by the famous Clydesdale breeder, Mr Lawrence Drew of Merryton, and described by the late Mr M'Neilage as a bull of great robustness of constitution, whose female progeny were full of style with grand frames and rightly-hung vessels. The most famous foundation sire appears to have been Hover-a-Blink. It was to these two foundation sires that any significant amount of inbreeding has taken place. The influence of Hover-a-Blink was chiefly upon the milk-producing groups. As late as 1928 bulls from the Drumjoan herd, which was transferred to Wyndholm in 1893, and again to Mortonmains in 1904, are responsible for the highest coefficient of inbreeding.

A Study of Some Points of Conformation and Milk Yield in Friesian Cows. *F. H. Garner. Journal of Dairy Research, Volume* 4, 1-10.—The main work was done on 500 recorded Shorthorn cows in Berkshire, but these figures had to be rejected owing to the differences in dairy and dual purpose types of the breed. Accordingly the writer made further measurements of pedigree and grade milk recorded Friesian cows of a uniform type, found near St Paul, Minnesota. The figures particularly refer to 57 cows, all of which were over 4½ years of age.

The milk yields were taken as produced by the cow, but all cows that had been in milk for more than 365 days were eliminated, and finally the total number of cows measured was 461.

The writer found that it was important that a cow should have a long body; the correlation here was not much but significant. He found that the height of the hind-quarters of the cow was more highly correlated with milk yield than the height of the fore-quarters. The coefficient of correlation between yield and width at the hocks was also significant, and bears out the opinion of judges who prefer a cow with a large pelvis girdle.

With regard to constitution, a significant correlation was obtained between the circumference of chest and milk yield, but not between depth and width of chest, though the writer concludes that these last two measurements could not be so accurately made as the first. "Capacity" was measured by the width of barrel at the thirteenth rib, and by the circumference of barrel, and again a significant correlation was obtained, namely +0·27 in respect of circumference of barrel.

With regard to measurements indicating mammary development, the writer points out that the blood leaves the udder by six different veins, and that only two of these, the so-called milk veins are visible. Where the veins turn suddenly upwards, some 6-12 in. from the fore-legs, the milk-wells are produced. The question arose as to whether the milk-wells were larger on bigger cows not because of higher milk yields but to be proportionate to the frames of the cows. It was found that the size of the cow did not materially influence the size of the milk-well. Measuring size by the height at the hocks, and holding this figure constant, a positive correlation was obtained between size of milk-wells and milk yield of +0·35. The writer concludes that the total area of the milk-wells is thus an excellent indicator of their milk-producing ability. Usually a large milk-well will take the tip of the middle finger of a normal man, and although one would never attempt to judge a cow by one point alone, the size of the milk-wells is probably the best single point indicating milk-producing ability. It is further stated that there may be a close relationship between the size of milk-wells in parent and their milking capacity of their daughters.

Pigs

Pig-Testing Results. 1933. *Iowa Agricultural Experiment Station. Leaflet No.* 30.—The Iowa Litter Testing Station is worked on the same principles as those employed in Denmark, Sweden, and Scotland, where four representative pigs of a litter are sent to a testing station, kept under identical conditions of husbandry, and the results then show the variation due to heredity. The Iowa results have an increased accuracy due to the fact that all the litter groups are farrowed about the same time, and hence any possible variation due to the season of the year is eliminated. At the Iowa Station the pigs are received at 10 weeks of age, and are kept on till they reach 225 lb. live-weight, when they are slaughtered, and the carcasses examined. The results in this leaflet concern some 17 litter groups farrowed between 2nd March and 8th May 1932.

The range in the average daily gain per pig between litters varied from 1·64 lb. to 1·13 lb., a difference in daily gain of more than half a pound per day. Nevertheless the pigs showing the most rapid gains were far from being the most economic. Actually they had the highest consumption of the protein supplement of any of the litter groups, but they were by no means uneconomic pigs.

The variation of the pigs within the litter group is an important factor, and this is clearly shown by the fact that the litter group with the lowest standard deviation, although it did not have such a high daily gain, was nevertheless the most economical producer of food, consuming 3·4 lb. of meal per pound of live-weight, as against the worst litter groups, which consumed 4·2 lb. of meal per lb. of live-weight gain. The difference in the protein consumption is not so clearly marked in this report as it was in previous ones, where the uneconomic pigs consumed twice as much as the economic pigs. In this report, as regards the protein, the most economic litter group was that already mentioned as having the lowest variation. For every pound of live-weight gain, these pigs consumed only ·63 lb. of protein as compared to the worst litter groups, which consumed ·85 lb.

Other figures are given, showing the cost of feed, the value of the carcass, and the margin between the two. This latter figure, which has to account for capital, labour, and the rearing of the pigs to 10 weeks of age, varied from $2·90 to $3·95. It must be remembered that the litter groups in this report are highly selected before being put on test.

ANIMAL NUTRITION

Loss of Nutrients and feeding Value in Haymaking and Storing. *H. Isaachsen, O. Ulvesli, and M. Husby. Meldinger fra Norges Landbrukshöiskole,* 1932, *12, Sept.* (*Inst. Animal-Nutrit., Roy. Agric. Coll., Aas.*—Investigations were continued for 2 years at the College and 6 others farms into the loss of nutrients and feed units when drying grass into hay and during storage in the barn. Digestion experiments were made both with the grass and the hay. Samples were artificially dried in the laboratory on wire netting by the aid of a fan. The grass was dried partly on the ground in cocks, partly on frames.

The loss of feed units when the grass was dried either in cocks or on frames was 14-15 per cent. In artificial drying, where as a rule the process was completed during 24 hours and where no mechanical loss occurred, the same number of computed feed units as in the corresponding grass was found.

During storage the hay, put into canvas sacks and kept in the barn for 29 (17-40) weeks. lost 8-10 per cent. of nutrients. The total loss in drying and storage was about

20 per cent. of the food units of the grass. It was thus considerably less than in most foreign trials, especially those of Wiegner (Zürich). It is suggested that part of the difference may be due to the fact that the grass in the present case was cut at a more mature stage than in the investigations of Wiegner.

Use and Value of Dairy by-Products as Food for Farm Live-stock. *F. Honcamp, W. Helms, Ph. Malkomesius, C. Eichler, and M. Sachsse. Biedermanns Zentralbl. B. Tierernährung,* 1932, *4,* 323-352. (*Agric. Exp. Stat., Rostock i, Meckl.*)—In trials with sheep and pigs the digestibility of dried separated milk and dried buttermilk was found to be approximately the same and well over 90 per cent. In a practical pig-feeding test dried separated milk, dried buttermilk, condensed whey (30·3 per cent. H_2O), and herring meal were compared as supplements to a basal ration of cereal meals, soya meal and potatoes, using amounts of each supplement that provided approximately equal supplies of digestible protein. In rate of live-weight gain, and efficiency of utilization of the ration, no significant difference was found between the three dairy by-products, but all were definitely inferior to the herring meal. The value of dried skim milk in the feeding of dairy cows was tested experimentally with disappointing results. Most of the cows showed a definite dislike for it, and its use in any case can be economic only when prices of oilcakes and other protein concentrates are very high.

Bone Charcoal as a Source of Minerals for Farm Animals. *H. E. Woodman. J. Minist. Agric.* (*Engl.*), 1932, *39,* 403-405. (*School Agric., Cambridge.*)—A short note giving the composition of bone charcoal. It is suggested that, since it has a high content of bone-forming constituents, it might be used in place of the more expensive bone flour.

Digestibility and Utilization of Steamed, Ensiled Potatoes fed to working Horses. *H. Wrede. Landwirtsch. Jahrb.,* 1932, *75,* 869-914. (*Inst. Agric. Chem. and Bacteriol., Friedrich-Wilhelms Univ., Breslau.*)—Steamed ensiled potatoes have been found suitable for working horses. The tubers must be cleaned before steaming, and should be allowed to lie for at least 24 hours after taking them from the tank. They should be mixed with chaff, and may be fed at the rate of 40 kg. per 1000 kg. live-weight, which amount was found to keep horses in good working condition. 1 kg. oats may be mixed with 3 kg. potatoes, and protein requirements must be taken into account. The sour potato diet apparently causes an increase in the digestibility of the crude fibre and N-free extract of the other constituents of the diet. Digestibility co-efficients of the food are given.

Is the Production of Certified Milk possible when feeding Sugar-beet Tops and Leaves? *H. Bünger, M. Seelemann, A. Werner, C. H. Wolf, and G. Sorge. Milchwirtsch. Forsch.,* 1932, *13,* 235-247. (*Prussian Dairy Res. Stat., Kiel.*)—Sugar-beet leaves, washed and unwashed, were fed to 2 groups of 4 cows, in quantities increasing over a month, without adverse results. Even quantities as high as 70-75 kg. per day were well tolerated so long as introduction was gradual and sufficient hay also given. Heavily frosted or frozen leaves produced diarrhœa. Although no difference in the cleanliness of the milk was apparent as between washed and unwashed leaves, washing is advised as a general procedure for production of certified milk of low bacterial count. Data on milk yield, fat content, and bacterial numbers are tabulated.

The Comparative Values of Cotton-seed Cake and Ground Yellow Corn for the Supplemental Feeding of Cows and Weaned Calves on the Range. *J. L. Lantow. Agric. Exp. Stat., New Mexico Coll. Agric. and Mech. Arts, Bull. No.* 202, *March,* 1932.—As a supplement to pasture on the range cotton-seed cake gave considerably better results than ground maize from the point of view of palatability as well as of gains in weight. Analysis of the pasture showed that the protein content was low and probably insufficient for the needs of growing cattle.

The Effect of Cod-liver Oil in the Ration upon the Quantity and Quality of Cow's Milk. *W. E. Petersen. J. Dairy Sci.,* 1932, *15,* 283-286. (*Div. Dairy Husb., Univ., Minnesota, St Paul.*)—Two groups of 6 cows were fed on a ration of alfalfa hay, corn silage, pasture and a grain mixture. The experiment was divided into 3 periods of 15, 23, and 20 days' duration. High grade cod-liver oil, 5 oz. per animal per day, was fed to Group I during the second period, and to Group II during the third period.

When cod-liver oil was fed there was a marked decline in the percentage fat of the milk with no apparent effect upon the yield. The depressing effect seemed to be cumulative, for a time, at least.

A Comparison between Ground Soy Beans and Linseed Oilmeal as Protein Supplements for Growing Calves. *J. H. Hilton, J. W. Wilbur, and S. M. Hauge. J. Dairy Sci.,* 1932, *15,* 277-281. (*Purdue Univ. Agric. Exp. Stat., Lafayette, Indiana.*)—In two trials, of 360 days and 330 days respectively, in which ground raw soy beans were used to replace linseed oilmeal as a protein supplement ~~in the ra~~tions of calves, it was found that both sources of protein were equally effective, especially when alfalfa hay instead of timothy was fed.

The Use of Skim Milk Powder in Grain Rations for Dairy Calves. *M. H. Berry. J. Dairy Sci.*, 1932, *15*, 287-292. (*Maryland Agric. Exp. Stat., Univ., Maryland, College Park.*)—Thirty calves were divided into 3 groups of which the first received a grain ration only, while the second and third groups received the same basal ration, plus 22 and 36 per cent. skim-milk powder respectively. All calves were weaned at 8 weeks old, when they were put on the experimental rations supplemented by clover hay *ad lib.* The results indicated that any increased weight or growth obtained by the addition of large amounts of dried skim milk to the grain rations did not justify the increased cost.

The Mineral Requirements of Pregnant Sows. *R. E. Evans. J. Minist. Agric.* (*Engl.*) 1932, *39*, 544-548. (*Animal Nutrit. Inst., Cambridge.*)—Metabolism experiments with in-pig sows demonstrated that the addition of ground limestone to a basal ration of barley meal, maize meal, bean meal, and blood meal, with an addition of ½ lb. salt per 100 lb. mixed meals, resulted in a higher daily retention of lime in the sow's body than where the basal ration was fed without lime. The daily retentions of lime were 0·33 g. for the basal only and 11·43 g. for the basal plus lime. The sows fed on the basal ration produced normal pigs, but were unable to rear them satisfactorily owing to deficiency of milk supply. The sows receiving lime produced and reared normal litters. To supply the requisite amount of lime and salt in a ration for in-pig sows where fish meal, meat and bone meal, separated milk or grazing are not available, the author suggests that 1 lb. 3 oz. of a mixture of 4 parts chalk and 1 part common salt should be added per cwt. mixed meals. During lactation the requirements of the sows will be greater, and 2½ lb. of the above mixture should be added to each cwt. of the ration.

The Influence of Maize Germ on the Quality of Bacon. *C. Crowther. J. Minist. Agric.* (*Engl.*), 1932, *39*, 428-440. (*Harper Adams Agric. Coll.*)—A series of pig-feeding experiments, conducted at three different experimental centres, demonstrated that degermed maize gives a better quality of bacon than ordinary maize meal containing the germ. The nutritive value of the former, as shown by the rate of growth, was equal to that of the latter. The determination of bacon quality was made by laboratory tests as well as inspection and factory reports.

Pellet *versus* Mash for Table Duck Production. *V. K. Tallent. Harper Adams Utility Poultry J.*, 1932, *17*, 539-543. (*Nat. Inst. Poultry Husb., Newport, Salop.*)—Mash-fed ducklings gave slightly greater gains in weight than pellet-fed ducklings for an almost equal food consumption and cost. Ducklings up to 5 weeks old will not eat dry pellets. These must be moistened in water.

Minerals and Vitamins in the Nutrition of Poultry. *W. Müller-Lenhartz, and G. von Wendt. Ztschr. Fleisch. u. Milchhyg.*, 1932, *42*, 364-367. (*Univ. Leipzig and Helsingfors.*)—It is suggested that bone meal alone is not a sufficient source of calcium for fowls and that Ca-compounds not containing P_2O_5, such as oyster and mussel shell, should also be given. To ensure high egg production, the ration should contain 0·5 per cent. salt (NaCl). Charcoal is recommended. Fish meal is a suitable source of iodine. In addition to covering mineral requirements, an adequate supply of vitamins must be ensured. Cod-liver oil is a source of vitamins A and D. Methods of testing the biological value of cod-liver oils are given.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS, AND FERTILISERS IN DECEMBER 1932, AND JANUARY AND FEBRUARY 1933.

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	DECEMBER			JANUARY			FEBRUARY		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ..	50 11	44 4	..	50 10	44 5	..	49 6	43 9	..
Cross-bred (Shorthorn)	45 7	40 1	25 9	46 10	41 6	30 8	46 2	41 2	30 9
Galloway	43 10	39 9	..	44 6	40 11	..	44 8	41 8	..
Ayrshire	39 6	30 6	..	40 9	33 8	27 11	40 9	35 0	28 0
Blue Grey	46 6	..	..	48 6	..	..	..	..	..
Highland	43 0	..	..	..	..	..	..	..	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	15	3½	..	15	3½	..	14¾	3½	..
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.
Cheviot	8½	7	6	9	7¾	6½	9	7	7
Half-bred	8½	7¼	5½	8¾	7¾	5¾	9	7¾	6½
Blackface	9	7½	6¼	9¼	8¼	6½	9¼	8	6¾
Greyface	9	8	5½	9¼	8½	6	9½	8¼	6½
Down Cross	9	7¾	5	9¼	8½	5¾	9½	8½	5¾
†PIGS—	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.
Bacon Pigs	7 11	7 6	..	8 4	7 10	..	8 6	7 9	..
Porkers	8 7	8 0	..	9 2	8 7	..	9 5	8 9	..

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

DESCRIPTION	DECEMBER			JANUARY			FEBRUARY		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—	Per head	Per head	Per head	Per head	Per head	Per head	Per head	Per head	Per head
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	15 1	11 4	8 3	14 18	10 14	..	15 0	10 18	8 10
Two-year-olds ..	18 6	15 3	..	19 0	15 18	..	20 2	15 15	..
Cross-bred (Shorthorn)									
Yearlings	14 5	10 2	7 18	14 1	9 18	..	14 13	9 19	7 15
Two-year-olds ..	17 6	13 17	..	17 18	14 8	..	19 0	14 16	..
Galloway:									
Yearlings	12 5	10 10	..	12 11	11 0	..	12 6	10 0	..
Two-year-olds ..	..	..	..	..	..	..	..	..	..
Ayrshire:									
Yearlings	..	..	..	10 15	..	..	..	..	..
Two-year-olds ..	..	..	..	..	..	..	..	..	..
Blue Grey:									
Yearlings	..	..	..	..	..	..	..	..	..
Two-year-olds ..	..	..	..	..	..	..	..	..	..
Highland:									
Yearlings	..	..	..	..	..	..	..	..	..
Two-year-olds ..	..	11 10	..	..	..	..	..	..	..
Three-year-olds ..	..	..	..	..	..	..	..	..	..
DAIRY COWS—									
Ayrshire:									
In milk	24 1	16 14	12 0	24 0	16 15	12 0	24 14	17 10	12 0
Calvers	24 15	18 16	14 3	24 3	18 10	14 6	24 7	18 3	14 1
Shorthorn Cross:									
In milk	27 17	19 8	..	27 12	19 8	..	27 18	19 18	..
Calvers	26 10	18 12	16 0	25 19	18 10	15 11	24 9	17 16	13 16
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ..	..	19 0	..	30 6	..	..	30 2	20 9	..
Half-bred Hoggs ..	..	24 0	..	35 3	23 7	..	34 10	27 6	..
Blackface Hoggs ..	21 3	15 9	..	23 2	17 7	13 0	24 0	16 4	..
Greyface Hoggs ..	28 6	22 0	..	32 6	24 6	19 0	31 3	23 10	21 2
Down Cross Hoggs	..	..	..	31 3	27 0	..	40 11	34 3	..
PIGS—									
(6 to 10 weeks old)	22 1	13 9	..	24 3	15 4	..	27 3	17 7	..

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	DECEMBER			JANUARY			FEBRUARY		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF :—										
Home-fed—										
Bullock or Heifer ..	1	7⅞	7⅜	9	8¼	8⅜	9¾	8¼	7¾	9½
	2	6⅞	..	7⅞	7⅝	..	8¼	7¾	..	8¼
Bull	1	6¼	6	5⅞	6⅛	6	6½	6	5⅞	6½
	2	5⅜	5½	5½	5½	..	6	5½	..	6
Cow	1	5	5⅛	5⅛	5⅜	5⅜	5¾	5½	5¼	5⅝
	2	4½	..	4	4⅞	..	5	5	..	4⅞
Irish—										
Bullock or Heifer ..	1	..	..	7⅝	..	..	8	..	..	8
	2	..	..	6⅞	..	..	7⅜	..	..	7½
Bull	1	..	..	..	..	..	..	..	..	..
	2	..	..	..	..	..	..	..	..	..
Argentine Frozen—										
Hind Quarters ..	1	4⅜	4⅜	..	4½	4⅜	..	4¾	4½	..
	2	..	3⅝	..	..	3¾	..	..	3⅞	..
Fore ,, ..	1	3⅞	3⅝	..	4⅛	4⅛	..	4⅛	4¼	..
	2	..	3⅛	..	..	3½	..	..	3⅞	..
Argentine Chilled—										
Hind Quarters ..	1	6⅝	6⅝	6¼	6½	6⅝	6⅝	6½	6¼	6½
	2	..	5⅞	6	..	6	6¼	..	5½	6⅛
Fore ,, ..	1	4½	4⅜	4	4¾	4⅞	4½	4½	4⅜	4⅛
	2	..	3⅝	3¾	4½	4⅝	4¼	..	4	3⅞
Australian Frozen—										
Hind Quarters ..	1	..	..	4¼	..	..	4¼	..	..	4⅛
	2	..	..	..	..	..	..	..	..	..
Crops	1	..	..	3½	..	..	3½	..	..	3⅝
	2	..	..	..	..	..	..	..	..	..
New Zealand Frozen—										
Hind Quarters ..	1	..	..	4⅛	..	..	4¼	..	..	4⅛
	2	..	..	..	..	..	..	..	..	..
Fore ,, ..	1	..	..	3½	..	..	3½	..	..	3⅜
	2	..	..	..	..	..	..	..	..	..
MUTTON :—										
Hoggs, Blackface ..	under 60 lb.	8¼	7¾	8	10⅜	9½	9⅜	11	9¼	9½
	60 lb. & over	7⅜	..	7⅝	9⅜	..	8⅝	10	..	8¾
,, Cross ..	under 60 lb.	8¼	7¾	8	10⅜	9½	9⅜	11	9¼	9½
	60 lb. & over	7⅜	..	7⅝	9⅜	..	8⅝	10	..	8¾
Ewes, Cheviot ..	1	..	5⅛	6	..	6⅜	6¾	..	6⅜	7⅜
	2	..	..	5⅝	..	..	6¼	..	..	6⅞
,, Blackface ..	1	5¾	5⅛	6	7⅛	6⅜	6¾	7½	6⅜	7⅜
	2	4⅞	..	5⅝	6½	..	6¼	7	..	6⅞
,, Cross	1	4¾	5⅛	6	6⅛	6⅜	6¾	6½	6⅜	7⅜
	2	3⅞	..	5⅝	5⅛	..	6¼	6	..	6⅞
Argentine Frozen ..	1	..	..	4¼	..	..	4½	..	..	4¼
	2	..	..	..	..	..	..	..	..	..
Australian ,, ..	1	..	4¾	4¼	..	5	4½	..	5¼	4¼
	2	..	3¾	..	..	3⅝	..	..	4	..
New Zealand ,, ..	1	..	..	4½	..	..	4⅝	..	..	4⅛
	2	..	..	4¼	..	..	4	..	..	3¾
LAMB :—										
Home fed—	1	9	..	8⅞	..	..	10	..	..	10¼
	2	..	..	8⅜	..	..	9⅝	..	..	9¼
New Zealand Frozen	1	..	6⅞	6¼	..	7¾	6⅜	..	7¼	6⅜
	2	..	5½	..	..	6⅝	..	..	6¼	..
Australian ,, ..	1	..	..	6⅛	..	..	5⅝	..	..	5⅜
	2	..	..	4¾	..	..	..	..	..	..
Argentine ,, ..	1	..	..	6⅛	..	..	5⅞	..	..	5¼
	2	..	..	..	..	..	..	..	..	..

EGGS : Monthly Average Wholesale Prices at Aberdeen and Glasgow.

PROVISIONS : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	DESCRIPTION	QUALITY	DEC.	JAN.	FEB.
			s. d.	s. d.	s. d.
ABERDEEN	Country .. .. per doz.	1	1 9	1 5	1 2
		2	1 8	1 4	1 1
	Duck .. .. ,,	1	1 9	1 5	1 3
		2	..	1 4	..
GLASGOW	Country .. .. per doz.	1	2 0	1 7	1 6
		2	1 9	1 5	1 5
	Northern Ireland per 120	1	19 10	15 2	16 5
		2	18 4	14 3	15 5
	,, (Cold Stored) ,,	1	12 7	..	..
	,, (Duck) ,,	1	15 10	15 10	14 9
	Irish Free State ... ,,	1	19 5	14 8	14 8
		2	18 4	14 1	14 1
	,, (Cold Stored) ,,	1	12 2	..	..
	,, (Duck) ,,	1	15 5	15 4	14 0
	Australian .. ,,	1	13 9	13 5	..
		2	13 0	13 0	..
	Belgian .. .. ,,	1	15 3	13 1	14 9
	Chinese (Black) .. ,,	1	..	10 3	9 3
	Danish .. .. ,,	1	17 8	13 3	15 3
	Norwegian .. ,,	1	..	..	14 0
	Polish .. .. ,,	1	11 7	..	..
	Swedish .. .. ,,	1	14 10	13 2	13 9

DESCRIPTION	QUALITY	DEC.	JAN.	FEB.
		s. d.	s. d.	s. d.
BUTTER :				
Argentine (unsalted) .. per cwt.	1	97 4	96 0	..
Australian .. .. ,,	1	91 6	88 0	83 3
,, (unsalted) .. ,,	1	98 6	93 0	87 3
Danish .. .. ,,	1	124 9	112 3	111 9
,, (unsalted) .. ,,	1	131 3	119 9	117 9
Finnish .. .. .. ,,	1	..	..	103 0
Latvian .. .. ,,	1	..	102 0	90 0
New Zealand .. .. ,,	1	92 3	90 6	84 9
,, (unsalted) .. ,,	1	104 6	96 6	90 0
Siberian .. .. ,,	1	91 9	90 0	..
Swedish .. .. ,,	1	118 0	106 3	105 0
CHEESE :				
Cheddar .. .. ,,	1	94 0	88 0	88 0
	2	68 0	79 6	84 0
Cheddar Loaf .. .. ,,	1	98 0	98 0	98 0
	2	85 4	87 8	84 0
Dunlop .. .. ,,	1	85 0	81 0	78 0
	2	74 0	74 0	72 0
Canadian .. .. ,,	1	77 6	74 0	74 0
New Zealand (Coloured) ,,	1	66 3	66 0	64 3
,, (White) .. ,,	1	67 9	58 6	54 0
HAMS :				
Irish (Smoked) .. .. ,,	1	122 0	114 6	122 0
	2	102 0	96 0	110 0
American (Long Cut, Green) ,,	1	79 0	75 6	64 0
,, (Short Cut) .. ,,	1	68 3	64 6	62 8
Canadian (Long Cut) .. ,,	1	78 6	71 0	63 4
BACON :				
Ayrshire (Rolled) .. ,,	1	96 0	97 0	100 4
Irish (Green) .. .. ,,	1	78 0	66 8	..
,, (Dried or Smoked) ,,	1	84 0	72 8	..
,, (Long Clear) .. ,,	1	76 0	74 0	81 6
Wiltshire (Green) .. ,,	1	88 6	89 0	95 0
,, (Dried or Smoked) ,,	1	94 0	95 0	101 0
American Sides (Cumberland Cut) .. .. ,,	1	50 6	47 9	52 0
Canadian Sides .. .. ,,	1	64 0	52 8	57 6
Danish Sides .. .. ,,	1	71 6	63 0	64 9
Dutch (Green, Wiltshire Style) ,,	1	63 6	53 6	56 0
Polish (,, ,, ,,) ,,	1	62 6	51 6	55 0

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter)

DESCRIPTION		QUALITY	DECEMBER	JANUARY	FEBRUARY
FRUIT:—					
Apples—	per		*s. d.*	*s. d.*	*s. d.*
Irish, Cooking ..	.. cwt.	1	18 0	18 0	20 0
American ..	.. case.*	1	11 0	11 9	12 3
	barrel.†	2	24 8	26 5	28 0
Pears, Californian..	.. case.*	1	13 8	14 6	15 0
VEGETABLES:—					
Beet	.. cwt.	1	5 0	5 0	5 0
Brussels Sprouts	.. „	1	12 0	12 0	11 6
Cabbage—					
Coleworts ..	.. dozen.	1	1 0	1 0	1 0
Red	.. „	1	2 8	2 6	2 6
Savoy	.. „	1	1 5	1 5	1 6
Carrots	.. cwt.	1	5 0	5 0	5 3
Cauliflowers—					
Broccoli, Cornish	.. dozen.	1	4 6	4 3	4 2
Other British ..	.. „	1	3 9	3 3	3 3
French ..	.. „	1	..	4 5	4 3
Italian ..	.. „	1	..	6 0	5 2
Celery	.. bunch.	1	1 8	1 6	1 8
Cucumbers ..	.. dozen.	1	14 4	..	..
Greens ..	dozen bunches.	1	6 0	6 0	6 0
Leeks	„ „	1	2 5	2 3	2 10
Lettuce, Cabbage	.. dozen.	1	1 10	2 11	2 9
Onions—					
Spring ..	dozen bunches.	1	0 5	0 5	0 5
Dutch	.. bag.‡	1	9 5	8 8	7 11
Valencia ..	.. case.†	1	10 6	9 3	8 6
Parsley	.. cwt.	1	10 0	11 6	12 0
Parsnips	.. „	1	7 0	7 0	7 0
Radishes	dozen bunches.	1	1 3	1 4	1 3
Rhubarb (forced)	.. cwt.	1	56 0	27 6	21 0
Spinach	.. stone.	1	3 5	3 9	5 6
Tomatoes—					
Scottish ..	.. lb.	1	0 6½	..	..
Channel Islands	.. „	1	0 4¼	..	..
Canary ..	.. „	1	0 4	0 3¾	0 3¼
Dutch	.. „	1	0 2¾	..	..
Turnips	.. cwt.	1	1 9	1 9	1 8
Vegetable Marrows	.. dozen.	1	3 0	..	..

* 40 lb. (approx..) † 9 stone (approx.). ‡ 7½ stone (approx.).

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee Edinburgh, and Glasgow.

(*Compiled from Returns received from the Department's Market Reporters*)

MARKET	Quality	FIRST EARLIES	SECOND EARLIES	LATE VARIETIES: RED SOILS: Golden Wonder	LATE VARIETIES: RED SOILS: Other	LATE VARIETIES: OTHER SOILS: Golden Wonder	LATE VARIETIES: OTHER SOILS: Other
		DECEMBER					
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Aberdeen, per ton	1	..	..	..	..	4 0 0	2 3 2
Dundee ,,	1	..	..	..	..	..	2 10 0
*Edinburgh ,,	1	..	..	4 0 0	2 10 0	3 0 0	1 9 5
Glasgow ,,	1	..	1 18 9	..	..	4 16 3	2 8 9
		JANUARY					
Aberdeen ,,	1	..	..	..	..	3 10 0	2 2 6
Dundee ,,	1	..	..	..	..	..	2 10 0
*Edinburgh ,,	1	..	..	3 17 6	2 8 9	3 0 0	1 10 0
Glasgow ,,	1	..	1 17 6	..	..	4 8 9	2 7 6
		FEBRUARY					
Aberdeen ,,	1	..	..	..	..	3 6 3	2 0 0
Dundee ,,	1	..	..	..	..	..	2 10 0
*Edinburgh ,,	1	..	1 5 0	3 6 3	1 17 6	2 12 6	1 6 3
Glasgow ,,	1	..	1 18 9	..	..	4 1 3	2 5 0

* Prices paid to Growers.

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(*Compiled from Returns received from the Department's Market Reporters*)

MARKET	Quality	ROOTS: Carrots	ROOTS: Yellow Turnips	ROOTS: Swedes	HAY: Rye Grass and Clover	HAY: Timothy	STRAW: Wheat	STRAW: Barley	STRAW: Oat	MOSS LITTER
		DECEMBER								
		s. d.	s. d.	s. d	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
*Aberdeen, per ton	1	..	..	..	50 0	..	..	..	25 0	..
†Dundee.. ,,	1	..	15 0	17 0	78 9*a* 60 0*b*	..	48 9	..	48 9	51 0*c*
‖Edinburgh ,,	1	..	..	..	52 6‡	..	33 9	32 6	33 2	..
*a*Glasgow ,,	1	..	..	..	55 0	60 0	41 3	..	37 6	31 3*d*
		JANUARY								
*Aberdeen ,,	1	..	..	..	51 3	..	..	..	..	..
†Dundee.. ,,	1	..	..	16 9	75 0*a* 61 3*b*	..	46 3	..	46 3	51 0*c*
‖Edinburgh ,,	1	..	..	..	52 6‡	..	32 6	..	32 6	..
*a*Glasgow ,,	1	..	..	..	55 0	60 0	40 0	..	37 6	31 7*d*
		FEBRUARY								
*Aberdeen ,,	1	..	..	..	50 0	..	..	..	..	..
†Dundee.. ,,	1	..	..	15 3	75 0*a* 65 0*b*	..	50 0	..	50 0	51 0*c*
‖Edinburgh ,,	1	..	..	..	52 6‡	..	32 6	..	32 6	..
*a*Glasgow ,,	1	..	..	..	55 0	60 0	40 0	..	37 6	31 3*d*

* Ex-farm, loose.
† Baled and delivered in town.
‖ Bunched straw, delivered.
‡ Delivered, baled or loose.
a Baled and delivered.
b Delivered, loose.
c Dutch moss litter, at quay.
d Home moss litter, in 1½-cwt. bales.

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	DECEMBER		JANUARY		FEBRUARY	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.
Linseed Cake—						
Home	7 18 9	7 15 0	8 5 0	8 3 2	8 11 3	8 8 9
Foreign	7 13 2	..	7 14 5	..	8 2 2	..
Decort. Cotton Cake	7 10 0	7 10 0	7 11 11	..	7 11 11	..
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	5 15 0	5 15 0	6 3 9	6 3 9	6 0 0	6 0 0
Palmnut Kernel Cake	7 10 0	..	7 12 6	..	7 11 3	..
Soya Bean Cake	8 0 0	..	8 0 0	..	8 0 0	..
Coconut Cake	8 5 0	..	8 3 9	..	8 2 6	..
Groundnut Cake, undecort.—						
(37 % Oil and Album.)	..	6 16 3	..	6 17 6	..	6 17 6
(46/50 % do. do.)	..	7 16 3	..	8 2 6	..	7 15 0
Maize Germ Cake, Home	7 6 3	..	7 8 5	..	7 6 3	..
Maize Germ Meal	5 17 6	..	5 16 7	..	5 12 2	..
Rice Meal	5 6 7	5 10 0	5 4 8	5 10 0	5 5 8	5 10 0
Bean Meal	8 5 11	8 7 6	8 0 11	8 6 3	7 19 1	8 3 9
Barley Meal	7 3 5	6 19 5	7 1 3	6 15 0	6 19 5	6 15 0
Fish Meal	14 16 11	14 15 8	14 16 11	14 17 6	14 17 6	14 16 11
Maize Meal—						
Home manufactured	5 15 8	5 16 11	5 14 5	5 15 8	5 16 3	5 19 5
South African (Yellow)	5 8 9	5 17 6	5 8 5	5 15 0	5 8 9	..
,, (White)	5 15 0	..	..	..	..	..
Locust Bean Meal (Fine)	6 11 3	5 17 6	6 12 6	5 17 6	6 12 6	5 17 6
Maize Gluten Feed (Paisley)	5 15 0	..	5 15 0	..	5 15 0	..
Maize—						
Plate	4 17 6	4 18 9	4 18 5	4 16 3	5 0 6	4 17 6
African (Flat)	5 9 5	..	5 7 10	..	5 6 11	..
Oats—						
Home	6 16 3	5 17 6	6 7 6	6 0 0	5 18 2	5 12 6
Plate	6 1 11	5 18 9	6 2 6	5 15 0	6 1 11	5 13 4
Canadian, No. 2	..	..	6 10 0	..	6 8 9	..
,, No. 3	7 0 11	..	6 10 0	..	5 18 9	..
Barley, Feeding (Home)	6 11 3	6 2 6	6 12 6	6 0 0	6 6 11	5 19 5
Wheat—						
Home	6 8 9	6 0 0	6 14 5	6 3 9	6 13 2	6 3 9
,, (Poultry)	6 10 10	..	6 12 6	..	6 3 9	..
Imported	6 16 7	5 17 6	6 17 10	6 5 0	6 14 8	6 0 0
Middlings (Fine Thirds or Parings)	6 6 11	5 19 5	6 5 0	5 15 8	6 4 8	5 16 11
Sharps (Common Thirds)	5 17 2	5 16 11	5 14 8	5 15 0	5 15 0	5 15 8
Bran (Medium)	5 17 6	5 17 6	5 17 11	5 18 2	6 2 10	6 3 2
,, (Broad)	5 16 3	6 15 0	5 18 2	6 11 11	6 2 6	6 17 6
Malt Culms	5 7 6	5 10 0	5 8 2	5 10 0	5 7 6	5 10 0
Distillery Mixed Grains, (Dried)	..	7 5 0	..	7 17 6	..	7 17 6
Brewers' Grains (Dried)	6 10 0	5 19 2	6 11 3	5 16 11	6 14 8	5 15 0
Distillery Malt Grains (Dried)	7 13 2	..	7 14 8	..	7 13 9	..
Crushed Linseed	13 10 0	..	13 10 0	..	13 10 0	..
Locust Beans (Kibbled and Stoned)	5 15 11	5 15 0	5 15 8	5 15 0	5 16 3	5 15 0
Beans—						
China	7 5 8	..	7 1 11	..	7 1 11	..
English	7 3 9	7 6 3	6 19 5	7 6 3	7 0 0	7 5 0
Egyptian	7 5 8	..	7 0 8	..	6 16 11	..
Rangoon (White)	6 5 8	6 5 0	6 7 6	6 5 0	..	..
,, (Red)	6 5 0	..	6 6 8	..	..	..
Pease—						
Calcutta (White)	..	..	9 10 0	..	9 3 2	..
Russian (,,)	..	7 15 0	..	8 0 0	..	8 0 0
Karachi (,,)	..	..	8 15 0	..	8 18 2	..
Feeding Treacle	5 0 0	5 7 6	5 0 0	5 10 0	5 0 0	5 10 0
Linseed Oil, per gall.	0 3 0	..	0 3 0	..	0 3 2	..

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(*Compiled from Returns received from the Department's Market Reporters*)

DESCRIPTION	Guaranteed Analysis	DECEMBER		JANUARY		FEBRUARY	
		Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	%	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.	per ton £ s. d.
Nitrate of Soda *	N. 15·5	8 12 0	..	8 14 0	..	8 15 6	8 16 0
Sulphate of Ammonia (Neutral and Granular) * ..	N. 20·6	6 2 6	6 2 6	6 5 0	6 5 0	6 7 6	6 7 6
Calcium Cyanamide †	N. 20·6	6 17 6	..	7 0 0	..	7 0 0	7 0 0
Nitrochalk * ..	N. 15·5	7 5 0	..	7 5 0	..	7 5 0	7 5 0
Superphosphate ..	P.A. 13·7	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6
,, ..	,, 16·0	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
,, ..	,, 18·3	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
Ground Mineral Phosphate ** ..	P.A. 26	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6
,, ,, ,, ** ..	,, 34	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Potassic Mineral Phosphate	P.A. 18 Pot. 10	3 16 3	..	3 16 3	..	3 16 3	..
,, ,, ,,	P.A. 21 Pot. 7·5	3 10 0	..	3 10 0	..	3 10 0	..
Kainit (in Bags) ..	Pot. 14	3 10 0	3 0 0	3 12 6	3 0 0	3 12 6	3 3 9
Potash Salts ..	Pot. 20	4 2 6	3 15 0	4 5 0	3 15 0	4 5 0	3 15 0
,, ,, ..	,, 30	5 11 3	..	5 15 0	..	5 15 0	5 3 4
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	9 17 6	9 10 0	10 2 6	9 10 0	10 2 6	9 13 9
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 15 0	11 10 0	12 0 0	11 10 0	12 0 0	11 12 0
Steamed Bone Flour	N. 0·8 P.A. 28	6 0 0	..	6 0 0	..	6 0 0	..
,, ,,	N. 1 P.A. 60	..	5 10 0	..	5 10 0	..	5 10 0
Bone Meal (Indian)	N. 4 P.A. 20	7 0 0	..	7 0 0	..	7 0 0	..
,, ,, ,,	N. 4 P.A. 45	..	7 0 0	..	7 0 0	..	7 3 9
Potassic Slag	P.A. 12 Pot. 6	..	3 10 0	..	3 10 0	..	3 10 0
Basic Slag ‡ ..	P.A. 13	..	1 17 6	..	1 17 6	..	1 17 6
,, ,, ..	,, 14	2 3 0	1 19 6	2 3 0	1 19 6	2 3 0	1 19 6
,, ,, ..	,, 15	2 7 0	2 1 6	2 7 0	2 1 6	2 7 0	2 1 6
,, ,, ..	,, 15·75	2 10 0	..	..	..	..	..
,, ,, ..	,, 16·5	2 13 0	..	2 13 0	..	2 13 0	..
,, ,, ..	,, 17·5	2 16 0	..	2 16 0	..	2 16 0	..

Abbreviations :—N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

** Fine grist, 90 per cent. fineness through prescribed sieve.

‡ Prices for Basic Slag at Glasgow :—F.o.r., in 6-ton lots, 80 per cent. citric soluble and 80 per cent. fineness; at Leith :—quotations 6d. per ton higher, carriage paid to Border Stations.

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THE ONLY FUTURE FOR BRITISH FARMING

A. G. STREET

Author of " Farmer's Glory "

RECENTLY, more and more people, even some of those who live and earn their living in our large cities, are beginning to look askance at our enormous bill for imported foodstuffs, at our dwindling export trade, and at the increasing number of our people who are unemployed. It is true that the townsman who is in work appears to be benefiting from the low price of foodstuffs, but he also realises that he is on the edge of a precipice. Should he lose his job, what then ? No wage earner or salary drawer wants to have to find an answer to that question.

On all sides he hears of the depression in the farming industry, and from his own observation he is bound to admit that, while the farmers may have cried " Wolf " needlessly in the past, to-day the wolf really is at the doors of the farming community. Leading statesmen in their speeches point out that we have idle acres and idle men, and suggest that these should be brought together for the benefit of everybody. About a year ago there was a conference of statesmen from every part of the Empire, with the object of organising the whole Empire as one unit for the purposes of production and commerce.

In spite of all this, nothing much seems to have been accomplished. The state of British farming goes from bad to worse, and more and more people are wondering whether there can be any future for our agricultural industry. " The land is here," they say. " Surely we should do something with it. We cannot let our farming die from neglect. It is our fourth largest industry. But what branches of it should we try to develop ? "

In order to try to find a sound answer to that last question, let us compare the farming land of Britain to an ordinary household garden.

Most people, who have households to cater for, have three sources of food supply—the garden attached to the house, shops which belong to their friends, and shops which belong to people with whom they have no intimate connection.

The statesman has to cater for a household of some forty-five million people, and he has the same three sources of food supply. The household garden is Britain's farming, the friend's shop is the Dominion's farming, and the other fellow's shop is the foreigner's farming.

The ordinary kitchen garden is used mainly for the production of those foodstuffs which can be grown there of much better quality than the purchased article. Salads, for instance. Too often the purchased salad is a very tired affair. If the garden is large enough to supply all the household's requirements, the main crop potatoes will be grown, but when the garden is too small to supply all the needs of the household for garden produce, the main crop potatoes will be purchased from a shop, and the garden will be used almost entirely to produce perishable foodstuffs which are of much better quality when fresh. Generally speaking, most people give their friends the preference when they purchase from a shop, going to the other fellow's shop when the first two sources of food supply, their garden and their friend's shops, prove inadequate.

Surely the statesman should do the same in his catering. He should use his garden, Britain's farming, mainly in the production of perishable products, not for wheat-growing, and give his friends, the Dominions, the preference when he is forced to purchase food, using the third source of supply,. the foreigner's farming, when the others fail.

This illustration of the household garden seems to be reasonably sound, but theories should not be put into practice without first considering how they may affect the different interests concerned. Our home farming must be run in the future to suit a lot of different people and a good many problems—Food Consumers, Maximum Employment on the Land, Large Farmers, Smallholders, Safety in time of War, Business interests in connection with the Balance of Trade, and the Needs of the Empire as a whole.

There appear to be three schools of thought to-day with regard to these questions. The first of these agrees with the garden illustration, and considers that our home farming should be developed to produce mainly perishable products, that is to say, market garden and live-stock products. The second says firmly that if wheat-growing in this country be made profitable there will be a new heaven and a new earth in about five minutes. The third wants to put a tariff on every farm product we produce, and damn the consequences. Let us see how these three policies suit the varied interests concerned.

The Food Consumer.—He is by far the most important person to be considered. British farmers must realise more than a good many of them do at present that their produce is not really sold until it goes into somebody's mouth, and that they cannot possibly get a living from farming unless they obtain the consumer's money somehow.

In order to obtain anyone's money legally it is necessary to sell them something which they wish to have, either services, knowledge, or goods. The farmer, obviously, must sell goods to obtain money, and, generally speaking, he says that he wants to sell wheat to the British consumer. But surely British wheat is the last thing the consumer wishes to buy from the British farmer. The consumer does not want the household garden to be used to produce the one farm product which he can import not only more cheaply but also of much better quality.

In comparison with the imported article, British wheat fails both in price and quality. Why ? Not because our farmers do not know their job, but because our climate is not favourable for wheat-growing. Five years out of six, wherever there is a good crop of wheat in this country it is laid flat by the weather before cutting. Again, more often than not, wet weather damages the crop after it is cut, and the grower is helpless in the hands of adverse weather conditions, which same conditions are eminently favourable to our other branches of farming.

A corn merchant, with fifty years' experience of the corn trade in this country, told the writer only this year that he could remember only six good grain seasons during a lifetime's trading. He cited the two jubilee years, 1887 and 1897 ; he found another good year in the early nineteen hundreds : then he came to 1911 ; then to 1921, and finally to 1929.

Therefore, in wheat-growing, the British farmer produces an indifferent quality article under great difficulties and at a high cost, whereas when he produces the perishable foodstuffs, he beats the whole world for quality, even if he does not do so for price. If there is to be any future for our home farming some farm products must rise in price, if the nation continues to insist on the present statutory costs of production such as labour and tithes. There may be a brief to make the consumer pay more money for a better quality article than imported, but there can be no brief to make him pay more money for an inferior article.

Maximum Employment on the Land.—Years ago, in the 'fifties, wheat-growing meant maximum employment, but to-day the position is very different. Owing to modern methods of mechanical cultivation and harvesting, it means exactly the reverse. Once grain-growing becomes profitable, in many cases total mechanisation of the farm takes place, with the result that the man-power is reduced to about one-sixth. Sir John Russell in his book *The Farm and the Nation* gives some interesting figures as to the employment to-day of men per hundred acres in different branches of agriculture. Market-gardening, 10-15 ; fruit, 5-8 ; dairying, 3½-4 ; mixed farming, 2½-3½ ; grazing and mechanised grain-growing, ½-1½ only.

It may be argued that the totally mechanised farm is an extreme case, and that only a small proportion of our farms can be run in this way. Very true, but it should be remembered that semi-mechanisation in grain-growing is possible on every farm. In conversation with a large farmer in Wiltshire the writer was informed that the farmer had grown more wheat owing to the Wheat Quota, and that he was getting £800 from this legislation. Further inquiry elicited two facts. First, that during the same year the farmer had lost over £4000 in his sheep-farming, and second, that in growing the extra wheat acreage he had not employed one single extra man, because his mechanical equipment rendered this unnecessary.

It is true that some forms of animal husbandry and market-gardening are being mechanised in part, but even so, the reduction in labour is not and can never be anything like so drastic as in modern grain-farming. Moreover, to-day the land of our country is lamentably under-stocked, and were animal husbandry to become profitable once more there would be a great increase of agricultural employment, and, it should be noted, employment of the better type man at a decent wage. Market-gardening, valuable as it is in the money value of its products, can never employ a vast acreage of our farming land, and the solution to unemployment amongst farm workers must come mainly from a development of our animal husbandry rather than grain-growing.

The Large Farmer.—The following poem describes the position of the British farmer quite fairly :—

The farmer will never be happy again—
  His heart is right down in his boots;
For either the rain is destroying his grain
  Or the drought is destroying his roots.

In fact when you meet this unfortunate man,
  The conclusion you'll come to is plain:
That Nature is just an elaborate plan
  To annoy him again and again.

To some the above may appear humorous, but it is nevertheless true, and in this country rain destroying grain does the farmer more harm than any drought can do to his farming. It is true that by using combine harvesters and crop-dryers it is possible to circumvent our climate when grain-growing, but can it be sound business to use a lot of expensive machinery to conquer our climatic conditions, when those same conditions are most helpful to our major branches of farming ?

We have a temperate climate. We rarely suffer from extremes either of temperature or drought. Consequently our land is admirably suited for live stock of all kinds. In this branch of farming we have an advantage over most of the world. We have the best grazing country in the world, save perhaps New Zealand, which is a long way from our market. Surely we should use our climatic advantages in this way, rather than persist in grain-growing, for which our land is not so well suited. This point has been observed by the farmers of Great Britain, and since 1879 there has been a steady turning away from grain-growing to animal husbandry and the production of perishable products. Surely what has been found to be the safest place for the individual farmer's capital should be where the nation should place its investments in agriculture.

For a number of years the prosperity of the British farmer has depended on his ability or otherwise to purchase cheap imported grain and feeding-stuffs as food for his live stock. Grain to-day is the product of about 10 per cent. of our farming, and the raw material of nearly 80 per cent. Surely the question of proportion must be considered. Roughly speaking, 10 per cent. of our farming, the grain-growers, want dearer grain: 80 per cent., the live stock men, want grain to be still cheaper, and the remaining 10 per cent., the market-gardeners, are not very interested either way, save that as they do employ a few horses, dearer horse-corn will harm their business. On balance, therefore, the cheaper grain is in this country, the better for our agricultural industry as a whole.

Even so, grain is a useful crop, and a prosperous live-stock industry in this country would always grow a certain amount, probably a greater amount than is grown at the present time, quite irrespective of grain prices. This amount of grain would be grown as and when the economic needs of each farm required it for rotational purposes and to provide straw.

The support for a wheat policy amongst farmers, who talk of it as being the pivotal crop upon which all our farming depends, comes from a desire to reduce the competition in their own branch of farming—dairying, for instance. It should be noted that the gangster and bootlegger always voted for prohibition in U.S.A., not because he believed in it on moral grounds, but because its continuance helped his own business.

To increase our wheat acreage would not make our agricultural industry prosperous. Wheat is but 5 per cent. of our farming output. If the wheat acreage were doubled, only the fringe of our farming would be concerned to any advantage, while the major portion would be adversely affected.

As an immediate relief to our grain-growing, and as a temporary policy, the Wheat Quota has much to recommend it. As a main permanent policy for British agriculture it is begging the real question. In short, a prosperous animal husbandry, which constitutes 80 per cent. of our farming, could and would carry our grain-growing, which represents only about 10 per cent. of our farming, at world prices; but our grain-growing cannot and never will be prosperous enough to carry our live-stock farming. In other words, the dog can wag its tail, but the tail cannot wag the dog.

Looking ahead from a business point of view, it is difficult to see any increase in the future demand for grain. The populace are eating less bread than formerly; there is a persistent lessening in consumption each year. Despite the recent alteration in the laws of the United States and the penny taken off the beer tax in this country, education, high taxation, prohibition, and the easier access to other amusements all tend to reduce the future demand for malt liquors, so that, except as an animal feeding-stuff, there does not seem to be much likelihood of any increased demand for barley. The future demand for oats appears to be still more hopeless. The main consumer of oats is the horse. Mechanical transport has displaced, and will still further displace, the horse on the roads, while mechanical power on the farm is displacing, and will continue to displace, the horse on the land. In addition, mechanical implements enable new land in suitable districts all over the world to be brought into grain-bearing more quickly. So the future would seem to hold out an increasing supply and a lessening demand for the three principal grain crops. Is it a business proposition for either the nation or the farmer to develop that side of our farming industry?

The land of this country is the one permanent asset which the nation possesses. Our manufacturing, our shipping, our export trade, all these may disappear, but our land will remain. It is indestructible. The farmer is, for the period of his farming, the trustee of this valuable national asset. If he farms mainly for grain-selling, he will have to be a very clever man if he leaves his land as good as he found it. In most cases, the reverse will take place. Conversely, the farmer who farms mainly to sell live stock and live-stock products will, almost invariably, leave his land better than he found it. Live stock enrich the land, grain impoverishes it. The live-stock man is, therefore, beyond question, a better trustee of the nation's asset than is his grain-farming cousin.

Many people refuse to discuss our farming policy except in terms of wheat, but to those with any real knowledge of our farming, wheat is comparatively unimportant. Ask any land agent, any auctioneer, or any bank manager, from John o' Groat's House to Land's End, who are the farmers who matter, who are the farmers who have any stability? You will get the same answer—the farmers, both large and small, who have live stock. For the past forty years, apart from the war period, the grain farmer has been but a hand-to-mouth individual.

Of course, everybody can see wheat and grain growing, and everybody likes to see it in the country-side. The glory of the harvest is instilled into all our minds. That is why wheat has, until now, always obtained such prominence in any agricultural discussion as to future policy. It is a pity that more people do not realise that wheat and grain are but the outward and visible sign in our farming, while live stock is the inward monetary grace.

The Smallholder.—Although many people look on the smallholder as a nuisance, and think that he does not amount to much in the farming industry, the aggregate produce of the smallholders of this country amounts to a very real contribution to the nation's larder. By far the major proportion of our smallholders are live-stock men, with their pigs, their cows, and their poultry. Very definitely, few of them grow wheat or other grain, and most of them are buyers of it. The town voter, while he has but little sympathy for the large farmer, is sympathetic to the smallholder. It is to be hoped that he realises that a wheat policy can be of little assistance to the smallholder, but rather the reverse.

Safety in Time of War.—The popular idea that increased wheat-growing in this country would be a bulwark in time of war is open to question. Continuous grain-growing on the bulk of our land materially decreases the fertility of the soil, whereas an expansion of our live-stock industry would enhance it, so that in time of need we should be able to cash the stored fertility in terms of grain. The writer had this said to him by a farmer one day. "Under this Wheat Quota, who wants to sweat to make some poor land better? Most farmers are looking for some good land in order to make it bad." That sounds horrible, but it is true. A large acreage of over-cropped, worked-out, dog-poor arable land would be a liability in war time, not an asset.

Any fear that to switch over from live stock to grain would take at least six months could be obviated by the storage of some months' supply of wheat in this country, as wheat will keep indefinitely. Moreover, such a storing would be a substantial cushion against the shocks of world-price variations, while the knowledge that we had some months' supply of bread in the country would be a much greater steadying influence on our vast industrial population in time of war or currency panic than a fleet of dreadnoughts. Have our statesmen who are preaching disarmament any right to do so without first making some provision of this kind?

The Balance of Trade.—We are purchasing nearly three hundred million pound's worth of imported food per annum for our enormous household. We have a kitchen-garden here at home. How best can we use this garden, our home farming, to reduce this gigantic bill for imported food? Obviously, by producing the more expensive foodstuffs here as much as possible. The garden is not big enough to supply all our requirements. We must import something. It is beyond argument that the perishable foodstuffs are more expensive than grain. In our daily menu it is not the bread which costs the money, it is the meat, the eggs, the milk, in fact, all the perishable things. Which shall we import? Cheap first quality wheat or stale eggs? During the first year of the Wheat Quota we shall have spent some six million pounds as a bribe to the British farmer to grow the one product which he produces of indifferent quality, and during that same period of time we shall have imported twenty million pounds' worth of stale eggs! Surely further comment is needless under this heading.

The Needs of the Empire as a Whole.—The main idea underlying any Empire scheme for agriculture is that each part shall produce mainly those products for which its soil and climate are best suited. Can we honestly say that wheat and sugar beet suit our farming ? Can we expect to make advantageous tariff agreements with those Dominions whose people are burning wheat and sugar, while we continue to subsidise those two comparatively unsuitable products at home ?

In any Empire scheme the home producer can claim fairly to have first place in the home market for suitable products, and these are definitely not wheat or beet, either on the grounds of price, employment, or quality of the product. As a whole, the British Empire is an exporter of wheat and grain, but as a whole it imports meat, dairy produce, and eggs. Surely that fact alone must point out that our home farming should be developed mainly to the production of these perishable products.

The Policy of Tariffs on every Farm Product.—Is not this rather absurd ? Would any business man dream of doing it, even if it were possible ? It is ludicrous to imagine a business man putting a tariff on wheat, and then discovering that as a result he had harmed a much bigger industry, the poultry industry, which, therefore, would need a still higher tariff on eggs. The same argument can be applied to barley and bacon, and to oats and horse feed. Any rise in the market price for grain automatically hardens the price of most animal feeding-stuffs. A tariff on grain, therefore, while it might help 10 per cent. of our farming industry, would harm at least 80 per cent. the live-stock side, including the majority of our smallholders.

If any national action is to be taken, a choice must be made of the branches of farming to be developed. It will be madness to spend money on all branches as their interests are opposed. In the writer's opinion this choice must surely fall on the perishable product side of our farming industry, as this branch best suits the needs of everybody concerned. In any case, even if the nation decides to continue to develop its grain-growing at the expense of the other branches of farming, no good can come from a hush-hush policy, and a suppression of the true facts concerning our farming to-day. In political and farming circles, whenever anyone mentions that wheat is but 5 per cent. of our farming output, he is told, " Yes, we know that is true, but for God's sake don't tell anybody." Surely we should use our knowledge, and discuss openly as to whether the old idea of Britain being mainly a wheat-growing country is sound or not.

It is the townsman who decides the fate of British farming, and the truth about this important industry has been deliberately kept from him. He goes to the country in his leisure hours, and looking over a hedge at a field of grass, he says, " Look at that. Just grass ! Why the dickens don't these lazy farmers do something with it ? "

He has never been told that grass is the most important crop in the British Isles ; that it is largely responsible for the supply of over fifty million pounds' worth of milk per annum, and that to grow grass in our temperate moist climate is, in the majority of cases, sound common sense and not a crime. He has never been told that the lowly hen brings in half as much again as wheat in pounds sterling to the British farmer in every year. He has never been told that wheat-growing in this country is only made possible by the keeping of live stock, and that animal husbandry does not mean all grass-farming. If he is to judge the agricultural question fairly, he must be told the truth.

If this is done, there can be no doubt but that the town voter will decide that the future of British farming must lie in the production of perishable products, mainly, of course, live-stock products. In other words, our kitchen-garden should be used mainly to produce FRESH FOOD, something which neither the Dominions nor the Foreigner *can* supply.

THE ECONOMIC CRISIS AND THE SCOTTISH FARM WORKER

JOSEPH F. DUNCAN

Scottish Farm Servants' Union

THE depressed state of Scottish agriculture is a matter of common knowledge and it is well that public interest should be aroused in order to encourage consideration of the existing situation ; but there is a regrettable tendency in some quarters to paint the picture too black and to give currency to inaccurate and misleading statements.

Thus it was announced just prior to the May term this year that ninety homeless ploughmen in Moray and Nairn would have to be accommodated in poorhouses and town halls, whereas there proved to be no necessity for any such course in the case of any ploughman's family in these counties. There was a number of married men who had been unable to secure places at the term in Moray and Nairn, as in all other counties in Scotland, and a few of them had difficulty in securing houses ; but the prediction of the necessity for housing large numbers of them was wholly unfounded and misleading.

It is necessary to emphasise that uncorroborated statements of opinion on agricultural conditions should be accepted with reserve. Even when every effort is made to secure accurate presentation of the facts, it is difficult to ensure a reasonably true picture because there is such a variety of conditions in Scottish agriculture. It is difficult to secure the facts in the first instance and then the classification presents difficulties. This is particularly true of labour conditions. Every engagement is an individual contract, and neither farmers nor workers are willing to let the terms of their contracts be known. In only a minority of engagements are the terms of engagement reduced to writing, so that even when inquiry is made either party may represent the conditions as being different from the actual terms, and such misrepresentation is not unusual. The best that can be done in any attempt to state conditions of labour is to give an estimate of the standard conditions, that is to say, the conditions applicable to the largest number of workers employed. The classification is rendered difficult, not merely by the variation from county to county, but the difference in methods of payment, family and personal wages, cash wages and wages paid largely in kind, and wages paid to boarders and bothy men.

For my purpose, which is to trace the effect of the world crisis on the position of farm workers in Scotland, it is not necessary to go into details of wages all over Scotland. I propose to take typical counties and to give the standard rates of wages in these counties to show the fall during the period of the depression. There was little change in wages from 1927 to 1930. In the Lothians and in the Glasgow area (which covers four counties), where wages during that period were subject to collective bargaining, the rates were maintained from 1927 to 1931. In other counties where there was no collective bargaining, market rates were inclined to sag a little, but as the numbers re-engaging were very greatly in excess of the numbers hiring in markets, the standard rates were fairly well maintained during these years. In the Lothians and the Glasgow area the changes can be given with accuracy, but in the other counties one has to rely on estimates. It is well to remember that market rates are not a very reliable guide as to the standard rates because when wages are falling there are fewer changes and men re-engaging have not usually to submit to such large reductions as the minority seeking new engagements in the markets.

The safest index for the standard wage of married men is to take the wage of ordinary ploughmen (excluding first men). In Mid and West Lothian the standard rates in 1930 were 36s. and 37s. a week with 12 cwt. of potatoes and house rent free. In 1931 the rates were reduced to 33s. and 34s., and from May 1933 to 30s. and 31s. In East Lothian the rate was 35s. in 1930, with 16 cwt. of potatoes and house, reduced to 32s. in 1931 and 30s. in 1933. In the Glasgow area the rate in 1930 was 38s. a week with 20 stones of meal and 8 cwt. of potatoes and house, falling to 36s. in 1931 and 34s. in 1933. In the counties on the Eastern Border rates fell from 35s. in 1930 with 1 to 2 tons of potatoes and house, to 32s. in 1931, 30s. in 1932 and 27s. in 1933. These figures may be taken as typical of the reductions in wages in the counties where wages are paid in cash. As typical of the counties where perquisites form a considerable part of the wages, I take the counties of Aberdeen, Moray and Ross, since these counties hire from the May term and it is thus possible to form a comparison with the counties given above where wages are mainly in cash. Here the figures must be given with more reserve because there has been no collective bargaining in recent years, and estimates must be based on rates which are not so standardised as in the counties where wages are paid in cash and there is a wider variation in the rates. In Aberdeenshire the usual perquisites are 65 stones of oatmeal, 3 pints of milk daily, 1 load of potatoes and 2 tons of coal. In Moray the milk may be 3 or 4 pints and 3 tons of coal, and 2 loads of firewood, and in Ross 80 stones of meal, 4 pints of milk, 1 ton of potatoes, 3 tons of coal and firewood. The cash wage in Aberdeenshire was £60 in 1930, £55 in 1931 and £50 in 1933. In Moray the cash wage was £65 in 1930, £62 in 1931 and £56 in 1933. In Ross the figures were £65 in 1930, £60 in 1932 and £55 in 1933.

Perhaps the best way to see the effect of these reductions is to set the rates out as a percentage of the 1930 rate. I have confined myself to the cash wages, and have made no attempt to value the perquisites. From the point of view of the workman it is not a matter of real interest whether the market prices of perquisites vary. Those workmen who sell a few of their potatoes or some of their meal may be a shilling or two up or down at the end of the year according as the prices have risen or fallen, but to the great majority of the workers who consume the perquisites, it makes no difference to their standard of living whether the values rise or fall.

	Border Counties	East Lothian	Mid and West Lothian	Glasgow District	Aberdeenshire	Moray	Ross
1930	100	100	100	100	100	100	100
1931	91·4	91·4	91·8	94·7	91·4	95·4	92
1932	85·7	91·4	91·8	94·7	91·4	95·4	92
1933	77	85·7	83·5	89·5	83·3	87·4	84·6

The cost of living figures issued by Ministry of Labour are not strictly applicable to farm wages, but they are the only official figures we have. I have expressed these figures for 1st May in each year as a percentage of 1930, and they show 1930, 100 ; 1931, 94·8 ; 1932, 92·3 ; and 1933, 87·7. These figures indicate a fall in real wages in every district except Glasgow, but, as I shall show later, the position is worse than these figures show.

It is much more difficult to give the reductions in wages of single men who are boarded and lodged or are in bothies. The fall appears to have been heaviest in the north-east, where it will reach a 25 per cent. reduction in the cash rates at May 1933 compared with May 1930. In the Glasgow area it is about half that amount. The other districts range between these two extremes. Women outworkers did not suffer any general reduction until 1933, when a reduction from 23s. to 21s. a week was made in the Border Counties and from 22s. to 20s. in East Lothian. There has been no general reduction in the wages of byrewomen and dairymaids because the demand still exceeds the supply.

It is necessary to repeat that these are standard rates, and that all workers are not paid at these rates. In every county some workers will be found who are paid higher rates and some who are paid lower rates. What is clear is that a growing number of farmers in every county are trying to engage men at rates below the standard. In the Lothians a farm paying wages below the standard was practically unknown before 1930, but since that time a number of farmers have been successful in hiring workers at 2s. a week below the standard, and in every county the same tendency is evident. They are encouraged to do this because there is a surplus of labour. Indeed, it is the surplus of labour which is the real cause of the fall in wages. There is no reason in the economic position of the industry why wages in the Border Counties should have been reduced every year, and have fallen further than in other districts in Scotland. It cannot be said that the sheep farmers of the Borders have borne the brunt of the depression. But any attempt to correlate reductions in wages with the incidence of the depression on different classes of farming would fail. The cause has to be sought in the surplus of labour.

This surplus has been created to a small extent only by the reduction in the numbers employed on the farms. The numbers employed, according to the Agricultural Returns taken on the 4th of June in each year, show the following percentage decline since 1930.

Workers regularly employed

	MEN 21 years and over	MEN under 21 years	WOMEN
1930 .	100	100	100
1931 .	98·6	97·4	97·2
1932 .	98	96·4	97·1

Workers casually employed

	MEN 21 years and over	MEN under 21 years	WOMEN
1930 .	100	100	100
1931 .	88·9	96	94·6
1932 .	89·5	92	87·2

We have no means of discovering the number of unemployed farm workers because no record exists. They do not come under the Unemployment Insurance Acts, and the majority of those unemployed would not qualify for assistance from the Public Assistance Committees. In the districts where the family hiring system obtains, a very large proportion of the families will have at least one male member of the family unemployed, very often the father if there were two or three members of the family to hire. It was a common experience at the indoor hiring registers in the Lothians and Borders this year to find that those registering were ready to hire although some members of the family could not be placed. In the east and north-east young men are much in excess of the demand. Some indication of the extent to which householders have been unable to secure employment can be found from the difficulty of finding housing accommodation. Until the last few years it was usual to find empty houses on most of the large farms, but now every house is occupied, and many householders have had to store their furniture, and find accommodation with their relatives and friends. There is now an acute shortage of housing accommodation of any standard in rural Scotland. Many of the unemployed farm workers have been compelled to find accommodation in houses which have been closed by the Local Authority because they were uninhabitable.

Scottish agriculture has been something like a corridor to other occupations. A glance at the figures of those regularly employed in the industry will show why this is so. The number of men of 21 years and over is just three times the number of those under 21 years. That means that about half those commencing as agricultural workers have to seek other occupations after they reach manhood. There was no difficulty about this for half a century before 1925. In spite of the steady reduction in the number of workers employed in agriculture the supply of farm labour in Scotland tended to be short of the demand. Emigration always took a heavy toll from farm workers, and the heavy industries and transport at home were ready to absorb a large number. Emigration practically ceased five years ago ; the tide has turned and the Dominions are sending workers home, while the acute depression in the heavy industries and in transport and trade has closed the doors to those who cannot find work on the farms.

The lowering of the standard rates of wages, even the fall in the level of real wages, is not the most serious effect of the economic crisis on Scots farm workers. A considerable number of families have been left entirely without the opportunity of earning wages, while a very large number of families have found their incomes reduced by the unemployment of members of the family, and farm wages have never been fixed at a level to enable such risks to be carried. They have been based on the supposition of continuous earnings and full employment. The result is a definite and serious lowering of the standard of living of the farm workers as a class, and as their standard of living was never more than a narrow margin above the subsistence level, the social result of this lowering is bound to be serious.

It may be of interest to compare the position of the farm worker in Scotland with that of the farm workers in other lands. Across the Border the Wages Boards have maintained rates in England better than anywhere. From 1930 to 1932 the decrease was 2½ per cent., but the basic rate of 30s. (out of which rent has to be paid and any allowances accounted for) has been maintained. The result is now that wages in several counties in Scotland are below those paid in England. Wages are now considerably higher in Northumberland than in Berwick. From the recent discussion in the House of Lords it is clear that there are numerous evasions of the legal rates in England, but standards have been better maintained than in Scotland. There is considerable unemployment, but as in Scotland, no means of estimating accurately. From figures supplied to me by the courtesy of the International Labour Office, it appears that the wages of hired men who are boarded and lodged in Canada and the United States have fallen in 1932 to 45·8 per cent. and 50·8 per cent. of the rates obtaining in 1927. In Europe the percentages in 1932 of the 1927 wages for men boarded and lodged were—Denmark 87, Norway 68, Sweden 94, Finland 75, and Germany 71. The figures for married men are not so complete, but taking 1927 as 100 they show for 1932, Italy 78, Denmark 87, Norway 69, Sweden 93, and Finland 71. In Holland I was informed that the reduction was 20 per cent. Except in Canada and U.S.A., where the fall took place in 1930, wages appear to have been well maintained until 1931, when the fall set in as it did with us.

In several of the European countries there are voluntary insurance schemes against unemployment in agriculture which receive State aid, so that records of unemployment are available. It is only proper to assume that those entering voluntary insurance are those most liable to the risk of unemployment, and the figures may overstate the actual extent of unemployment amongst all farm workers. They show, however, the effect of the economic conditions of the last few years. The Report presented to the Seventh Session of the International Labour Conference at Geneva in 1933 on Unemployment Insurance gives a wealth of information on unemployment in the various countries. It shows that in Denmark the unemployment of farm workers in 1932 was three times the normal unemployment; in Germany in July 1932 it was eight times what it was in July 1929; in Italy it rose from 89,000 in 1929 to 165,000 in 1931; while in Holland the State had to treble its grant for unemployment between 1929 and 1932. It is clear that unemployment is much more serious on the Continent than it is with us.

I trust I have made it clear that the position of the Scots farm worker is not solely dependent upon any measures which may be taken to restore prosperity to the industry. Even if we can restore the price levels of 1925, we cannot provide work for the growing number of unemployed workers. Nor can we hope that Scottish agriculture will be able to load on to the shoulders of other industries in this country the workers it cannot employ, or send them to undeveloped lands in other countries. The epoch of the pioneers on the undeveloped lands overseas was closing before the economic crisis put a sudden stop to emigration, and not the most optimistic amongst us can hope to see extending industry at home providing openings for the surplus farm workers. Agriculture will have to shoulder its share of the burden of providing for its own unemployed workers. Until it can reorganise its affairs so as to provide employment for a larger number, those workers who are denied employment have a right to maintenance equally with unemployed industrial workers. The last three years have demonstrated the need for provision against unemployment of farm workers, and when the Government addresses itself to the task of reorganising the Unemployment Insurance Scheme, as it must do this year, it will be met by an irresistible demand from the farm workers for inclusion, a demand which cannot be refused on any grounds of equity or lack of necessity.

Nor can the farmers expect to be given statutory powers to control the marketing of their produce and the regulation of imports to protect them against glutted markets, and to be left free to buy their labour in a free market with a permanent surplus of labour. If it is to be the policy of the nation to protect the farmer from unregulated competition, the same protection cannot be denied to the workers, whose standard of living is endangered by a surplus of labour forcing down wages. If the farmer is to have the power to protect himself against price-cutting of his produce, the worker is equally entitled to be given power to protect himself against price-cutting of labour. Neither the farmers nor farm workers in Scotland have been in favour of legal minimum wages. They believe it is possible to work out a satisfactory system of collective bargaining in Scotland which would avoid the necessity of statutory fixing of wages and yet secure the maintenance of reasonable standards. We have had experience of collective bargaining in Scotland, and it has been shown that, when agreements have been reached, satisfactory standards can be maintained. When agreements have been made they have been accepted by the great body of farmers and workers, and have been generally observed without the need for legal enforcement. Experience in other countries has shown that the method of collective bargaining in wages in agriculture is a workable arrangement.[1]

The initiative will require to be taken by the State, but no elaborate machinery is necessary. A simple experiment could be made by the Department of Agriculture being empowered to convene the representatives of farmers and workers in the different areas to meet under an independent chairman for the purpose of framing a collective agreement on wages and working conditions. If an agreement was arrived at, it would be issued as a recommendation of the conditions upon which engagements should be made. If either party failed to appoint representatives, or the representatives failed to agree, the chairman should be empowered to issue his own finding as to what the conditions of engagement should be.

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[1] "Collective Agreements in Agriculture." *Studies and Reports, Series K* (*Agriculture*), *No.* 11. International Labour Office, Geneva. 3s.

Such agreements or findings would have no legal or binding effect but would be simply recommendations to the farmers and workers concerned, but judging from past experience, they would be generally accepted by both sides. There would be sufficient flexibility to suit Scottish conditions and temperaments, and the method would be preferable to legal minumim rates. If the standard of living continues to fall, the State will be forced to protect the workers on grounds of social policy, and that will mean the legal enforcement of minimum rates. I believe there is enough public spirit amongst those engaged in Scottish agriculture to work out a solution of its own problems without the need of compulsion.

STERILITY IN FARM LIVE STOCK[1]

A. D. Buchanan Smith, M.A., M.Sc., B.Sc., F.R.S.E.

Sterility.—An important factor in the economy of animal production is the length of life of the breeding stock and the rate at which new generations are produced. A number of competent investigations conducted in this country have shown that the effective breeding life of a cow is, on the average, only three years. Fifty per cent. of the total life of the cow is occupied in reaching a productive age, leaving only 50 per cent. during which she is capable of producing the requirements of mankind. Roughly, one quarter of our breeding cows have to be replaced each year. The causes for this replacement are various, but in every recent investigation the major single cause has been found to be sterility.

Similarly, in horses it has been shown that the average annual sterility amongst mares amounts to between 40 and 50 per cent., and that in recent years this figure shows signs of increase. In sheep, where absolute sterility is comparatively rare, reduced fertility is not uncommon, and in certain breeds and districts there has been of late years a distinct lowering in the number of lambs born per hundred ewes. For the reorganisation of the pig industry, as presently contemplated, it is essential that every sow in the herd should produce annually two litters of eight piglings each. While certain breed records demonstrate that on selected sows this figure has been attained and exceeded, there is evidence to show that the total annual production of pigs weaned in the average herd is about 12, as compared to the 16 required by the Pig Reorganisation Commission for efficient and economic production.

Recognising the losses due to sterility suffered by the stock breeders of this country, representatives of the various research institutes and colleges formed a committee of liaison, whereby each individual could obtain a fuller appreciation of the subject with a view to a more complete investigation of this important problem. One outcome of this committee has been the establishment at the Royal (Dick) Veterinary College of a clearing-house for specimens where the *causes* of sterility may be sought. Another result has been the publication by the Imperial Bureau of Animal Nutrition and the Imperial Bureau of Animal Genetics of two critical reviews dealing respectively with the nutritional and hereditary aspects of the problem. To each of these reviews there have been attached bibliographies of scientific contributions. These reviews and bibliographies can be obtained from the Chief Officer of the Bureau concerned; at the Rowett Institute, Aberdeen (price 6d.), and the Institute of Animal Genetics, the University of Edinburgh (price 2s. 6d.).

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[1] This article has been compiled from data collected by the Scottish Committee of Research Workers' Sterility Sub-Committee. In the preparation of the paper, the writer desires to acknowledge the helpful co-operation of Dr J. B. Orr, Rowett Research Institute; Prof. W. M. Mitchell, Royal (Dick) Veterinary College; Dr N. C. Wright, the Hannah Dairy Research Institute; and Prof. F. A. E. Crew, Institute of Animal Genetics.

The scientific approach to any problem implies the orderly arrangement of knowledge concerning that problem. Our knowledge having now been reduced to order, the purpose of the present article is to summarise these results, and to present them in non-technical language whereby the stock breeder may gain some information which may assist him in his practice. For a detailed and lucid account of the reproductive system, the reader is advised to turn to Bulletin No. 39, published by the Ministry of Agriculture (price 1s. 6d.), entitled "Fertility and Animal Breeding," and written by Dr F. H. A. Marshall, F.R.S., and Dr John Hammond, F.R.S., of the School of Agriculture, the University of Cambridge. In many ways the present contribution is supplementary to that publication.

The causes of sterility are many, but they may be discussed under three main headings: infectious disease, nutrition, and heredity. There is, however, much overlapping between these groups, but for the sake of clarity an attempt is made to deal with them in this order. While the observations deal principally with cattle, other animals are not excluded; but where no specific mention of the animal is made, the reference is to cattle. No list of references to specific scientific papers is attached, since these can be found in the reviews and bibliographies referred to.

Disease.—According to many observers the chief cause of sterility is contagious abortion, which is due to the organism *Brucella abortus*. This disease is widespread and appears to be increasing. It has been stated that 80 per cent. of infected cows abort only once; but it has also been shown that an outbreak of this disease is followed by a loss in breeding efficiency, *i.e.* more services are required before the cows will settle in calf. Some investigators state that of cows which abort only once 20 per cent. become permanently sterile. Others, from their experience, find this figure too high. In general, it is probably the case that contagious abortion is often followed by secondary infections which are liable to cause chronic inflammation of the reproductive passage, particularly of the lining membrane of the uterus (endometritis), and that it is this inflammation of the genital organs which gives rise to sterility. Under hygienic treatment such inflammation may subside before permanent harm is done. The wisest plan is to obtain the services of a competent veterinarian for the treatment of the reproductive tract immediately after abortion.

An outbreak of contagious abortion may be attacked by one of three methods. The cows may be vaccinated with the live vaccine. This is frequently effective, but the animals are a permanent reservoir of infection, and all additions to the breeding herd must be vaccinated before being put in calf, otherwise abortion may occur. This method should be employed only when a herd is already badly infected.

Secondly, there may be innoculation with the dead virus. This method has also been employed but with a lesser degree of success. Though these two methods may reduce the incidence of abortion, the sterility rate from secondary infections may remain high.

Thirdly, there is the isolation method whereby all cows which react to the agglutination test for contagious abortion are isolated. Repeated testing of the non-reacting cows should be carried out at intervals of one month until two consecutive tests prove negative. Calves from reacting cows tend to overcome infection as they approach breeding age, and may be added to the clean section of the herd if an agglutination test is negative. An outbreak of contagious abortion has such serious and far-reaching repercussions that the prudent breeder should be guided in his action by his veterinary adviser. Any farmer starting a new herd should purchase only animals which have passed the agglutination test. This test should be repeated at monthly intervals until two successive tests of the herd are negative; similarly, all additions to the herd from an outside source should be kept isolated until two successive tests have been passed. Such additional expense should be treated in the light of an insurance premium against the disease.

There appears to be good ground for the view that diet affects susceptibility to infection. Bacteriological studies show that the organs of the non-pregnant cow contain many bacteria which are usually harmless, but assume a pathogenic role under unfavourable influences. It has been shown, chiefly with laboratory animals, that deficiency of vitamin A alters the condition of the mucous membranes of the respiratory passages and the defence mechanisms of the body, so that organisms which normally exist in the body without causing signs of disease become pathogenic. A rickets-producing diet, fed to rats which are normally immune to tuberculosis, causes them to become highly susceptible. Hence there is an increasing tendency to believe that these infections of the genital tract may be, to some extent at least, the result of poor condition and improper feeding.

There is no direct evidence of a hereditary immunity to this disease, though some work with smaller animals indicates that such a factor may exist. Selective breeding may not therefore be the most rational nor economic method of combating the trouble.

Infections other than contagious abortion and chronic endometritis are of less importance.

Ovarian Changes.—Cystic degeneration of the ovaries (the two bodies which give rise to the egg cells) probably occurs most frequently in early-maturing, high-milking breeds under intensive conditions. In all likelihood this is due to a combination of three principal factors. Where the hereditary constitution of a cow is capable of being forced for high production, then the reproductive organs can stand the strain. An excellent illustration of this can be found in the breeding histories of some British Friesian 2000-gallon cows, some of which are consistently able to make high records without any impairment of their reproductive ability. But it must be recognised that often the nutritional demands for early maturity, frequent breeding and sustained high-milk production are not fully met. We may attribute to this cause the sterility following record-breaking performances in milk production. The output of mineral matter in high-milk production is enormous, and, unless special provision is made to meet the requirements, depletion of the skeleton is bound to occur. Cystic degeneration is frequently followed by a modified form of sex reversal. The condition may occur in non-pregnant animals including heifers. These changes in the ovaries are probably due to alterations in the secretions of certain glands. Research on this subject is being prosecuted with vigour.

The *corpus luteum* is a body which is normally shed after the cow has given birth to a calf. The above conditions may prevent the release of this corpus luteum which, if the condition is not severe, may be overcome by manipulation. This again is a matter for the veterinarian, since an unskilled attempt is almost certain to cause further complications. An indication that the *corpus luteum* is retained may be found in the fact that the cow, instead of coming into heat every three weeks, has a period of a month and upwards.

Disease in the Male.—The part played by the male has now come to be recognised as of considerable importance. In the first place, it is doubtful whether with reasonable hygienic treatment after service the bull plays an important part in the transmission of contagious abortion, though the causal organism has been associated with the formation of abscesses in the male generative organs. But inflammatory conditions of the male reproductive organs have been definitely shown to be associated with an infection of cows causing a parallel inflammation. The relationship between inflammation and the production of deformed sperm cells, while not clearly worked out, is probably fairly close. In the normal healthy bull the seminal fluid is generally bacteriologically sterile. The presence of bacteria is usually associated with sterility.

At the conclusion of this section of the article the reader must not be disappointed that no specific treatments have been advanced which he himself could put into practice. It is a paradox that as the nature of disease becomes better understood, so do the complexities increase. Just as there are several forms of disease each attacking several different parts of the reproductive system both of the male and of the female, so there must be several different kinds of treatment. It is not reasonable to expect to obtain a simple universal cure. To find the right treatment demands the correct diagnosis of the trouble. This is a job for the specialist, and hence the advice which has been given.

Nutrition.—Life itself depends on adequate nutrition. Reproduction is the fundamental form of the life of any species. Diminished fertility due to famine and war is known in all classes of farm animals and in human beings. On poor grazings, for instance, the lamb crop may be as low as from 25 to 50 per cent. It has been shown that following the War, sterility amongst the sheep of Austria and Germany increased from 10 to 40 per cent.

Likewise over-feeding is frequently harmful to good breeding performance. " Speaking generally," state Marshall and Hammond, " there can be no doubt that whatever the actual condition of the animal, a rising or improving state of nutrition before service is more favourable to fertility than a stationary or falling one." This can be seen in the practice of " flushing " ewes. The nature of the feed used to produce the flush is relatively unimportant. In animals that are fit but not over-fed any sudden increase in feed will stimulate ovarian activity, promote the occurrence of œstrus and increase the number of eggs which are shed. In a series of observations on a total of 1033 flushed ewes, the number of lambs per 100 ewes was 154, as compared with 140 in 4054 ewes not flushed. In another series, flushed on extra good pasture, the lambs per 100 ewes were 164, as compared with 143 from control ewes.

Mineral Deficiency.—Naturally occurring deficiencies of mineral elements have been shown to affect fertility. Of these phosphorus deficiency is probably of the chief importance since it is the most widespread. In South Africa, Australia and the United States it has been clearly shown that deficiency of phosphorus results in abortion and sterility. A diet low in phosphorus greatly lengthens the interval between the periods of heat. In the United Kingdom phosphorus deficiency is not acute.

Calcium (lime) deficiency, which is of less importance to the world at large, has been shown definitely to lower the fertility of some flocks in the hill pastures of Scotland. Calcium is essential to reproduction in all classes of farm live stock. For instance, in pigs a deficiency of lime in the ration of breeding sows leads to a considerable increase in the number of pigs born dead. In this connection it must be remembered that lime is not easily assimilated and that the presence of vitamin D (cod-liver oil) assists the digestion of this element.

The importance of lime and phosphorus may be gauged from the following American experiment which was designed to produce contagious abortion in young heifers by feeding suspensions of cultures of *Br. abortus*. The experimental animals were fed first on pasteurised milk and later on a ration deficient in these two minerals. No contagious abortion developed, but great difficulty was experienced in breeding the heifers, the control group being even more affected than those fed the cultures. After three months on a " well-balanced ration," all the heifers came in heat and were successfully bred.

In certain areas of the earth a marked deficiency of iodine occurs, where it is usually accompanied by goitre. In such areas the addition of this mineral has a beneficial effect on fertility and in the case of pigs a reduction in the number born dead. A shortage of iodine in the diet is not necessarily confined to these deficient areas. A four-years' experiment at the Rowett Institute indicates fairly clearly that in stall-fed cows there may be a relative deficiency of iodine adversely affecting reproduction.

Where an abundance of available fluorine is found, there is evidence to show that an excess of this mineral leads to sterility.

Protein (*digestible nitrogen*).—In natural grazings a deficiency of phosphorus usually is correlated with a low nitrogen content of the pasture, especially in the mature herbage and under drought conditions. In many cases it would be impossible at present to judge what part of the effect of such grazings in reducing fertility is due to under-nutrition and what part to deficiency of phosphorus or protein.

Numerous experiments on small animals have been made which show the great importance of both the amount and the quality of the protein supplied for breeding efficiency. Age at puberty, the length of the reproductive span and the size of litters are all affected by the quality of the protein fed.

Roughly speaking, the different kinds of protein may be divided into two main types, that derived from animals and that derived from plants. Animal protein is far more favourable to reproduction than is plant protein. In rats it has been shown that sterility is high on a vegetarian diet. This effect is cumulative from one generation to another.

It has also been shown, again with rats, that there is a danger in the overfeeding of protein, and that this should not exceed 14 per cent. of the total ration. This level has been shown to be the best both for litter number and the length of the reproductive life of the individual.

In poultry feeding it is well recognised that sufficiency of calcium and phosphorus and an adequate supply of good quality protein are essential for egg production. Optimum quantities and ratios are being determined by experiments at all the main centres of research. According to the most recent results, plant protein, adequately supplemented with calcium and sodium chloride, may give as good results as animal protein. There are, however, no data to show whether this is true for mammals.

Vitamins.—The vitamin most clearly connected with reproduction is vitamin E. This vitamin occurs in nature chiefly in green vegetables, notably lettuce, and in the embryos of certain cereals, especially wheat. It is found in milk and egg-yolk, and is present in muscle, fat, and to a less extent in the liver. It does not occur in plant oils, and is apparently absent from cod-liver oil, kidney, brain and testis. A diet free from vitamin E does not prevent maturation or shedding of ova in rats. A first litter may even be born, but as depletion of reserves proceeds, a characteristic condition with death and absorption of the fœtus results. In males, the sperm becomes lifeless and then disappears.

More recently it has been shown that a deficiency of vitamin A causes a degeneration of the reproductive tissue leading to complete sterility. This effect is more rapidly produced than in the case of deficiency of vitamin E.

From time to time it has been suggested that other vitamins were necessary for reproduction. It is doubtful, however, whether deficiency of vitamin B has any specific effect on fertility. Vitamin D appears, at least under certain conditions, to be necessary for normal reproduction in birds, but this is again probably only a secondary effect associated with the effect of vitamin D on mineral metabolism and the high mineral requirements for growth of the egg.

It is uncertain whether deficiency of vitamins affecting fertility occurs under natural conditions. It has been thought that vitamin E might be deficient in the rations of farm animals, particularly those stall-fed on poor rations. Experiments have therefore been made to test whether the feeding of sprouted oats would influence sterility in cases not attributable to any definite pathological, *i.e.* disease, condition. The results, although suggestive, are inconclusive.

Diet and the Male.—It has been shown that the production of semen by the stallion is definitely related to quality of the food and that eggs and bran have a stimulating effect. There has been reported a case of sterility in a boar fed on Canadian field pea screenings. A change of diet to a balanced ration restored fertility within six weeks. Before the change in diet the acidity of the semen was high and there was little life in the sperm. The altered diet lowered the acidity and increased the vigour of the sperm.

To sum up, it may be stated that nutrition has a threefold effect on the fertility of farm live stock.

1. Animals receiving an insufficiency of food cannot be expected

to reproduce normally, because their reproductive organs are starved. The general condition of an animal, particularly just prior to and at mating, has a direct effect upon fertility.

2. An otherwise balanced ration may be deficient in one substance requisite for fertility. The animal may otherwise be normal. The deficiency is most likely to be phosphorus, calcium, vitamin A, vitamin E, or an animal protein. It is possible that the excess of a specific substance can also lead to sterility.

3. In addition to the direct influence of diet on fertility there is the indirect effect through its modifying action on susceptibility to infection. It is known that malnutrition affects the powers of resistance to certain infections, and there is evidence that it is a predisposing factor to infection with the organism causing abortion ; but how important this precise relationship may be is still a matter of dispute.

Heredity.—The hereditary (genetical) aspect is, as regards commercial cattle, of secondary importance because it does not pay the commercial cattle breeder to waste time by trying to get a difficult cow in calf. It is cheaper to fatten her and send her to the butcher, a sound practice if the sterility be due to hereditary causes. As regards pedigree cattle, horses, sheep, pigs and poultry, it is by no means unusual to find that the hereditary factor is one limiting the optimum rate of reproduction.

One type of hereditary sterility is due to *lethal factors*, for instance, that which causes the production of what are known as " bulldog " calves. These calves are monstrous dwarfs, and are not carried to full-time by their dam, being aborted usually between the fifth and the seventh months of pregnancy. It has been shown that this is due to the interaction of two genetic factors. Although a great deal is known about lethal factors in the smaller animals and in plants, little is known of them in cattle, but there is every reason to assume that their existence is more common than one might suppose. A lethal factor may act on the very young embryo and kill it at an early stage ; the fœtus may then not be aborted but absorbed into the tissues of the dam. This may be one reason why a cow apparently settled by a bull has not come on heat again for a couple of months, and towards the end of an apparently normal pregnancy has shown some signs of heat ; or worse, has carried on and only proved not to be in calf shortly before her normal time of calving.

A similar case is found in the Welsh Mountain sheep where the lambs which die at birth or soon after have limbs rigidly fixed in various positions, only a slight degree of movement being possible at the joints affected without breakage of the limb. In pigs there is evidence of the operation of lethal factors, when variations in litter size are considered. Inbred strains of pigs tend to give small litters. Several workers have given their attention to litter size in swine, and in post-mortem examinations of pregnant sows many examples of atrophied fœtuses and circumstantial evidence of reabsorbed embryos have been found. Scrotal and umbilical hernia (rupture) in pigs appear to be hereditary defects acting in a semi-lethal manner.

There is accumulating considerable evidence to demonstrate the presence of lethal factors in poultry. It has been shown that it is not possible to breed pure strains of "dumpy" fowls, as the individuals inheriting these characters from both parents in a pure state perish in the egg before hatching. The dumpy fowl is analogous to the Dexter breed of cattle. Death in the shell is important; 12,000 eggs which had failed to hatch were examined, among which were over 5000 embryos which died after the eighteenth day. When it is remembered that loss to poultry keepers by mortality among embryos during incubation is probably second only to that incurred by disease, the importance of these studies on hatchability and embryonic mortality can be realised.

Mechanical embarrassment to efficient sexual congress may prevent service. A similar result obtains when the vagina of the female is of abnormal size, that is, when either the distance from the opening of the womb to the external parts is greater than usual, or when the diameter is smaller. And the same holds in the converse, when the bull has a corresponding disharmony. There is every reason to believe that both these abnormalities are inherited, though for obvious reasons the situation has not been "taped out."

A similar case is that of "White Heifer Disease." This is an unfortunate name, for the trouble is known to occur in other than white animals. This condition is due to a block in the passage leading to the womb, and is frequently accompanied by some other abnormality of the genital organs. Although when young the heifer is sometimes able to elaborate eggs, it is impossible for the sperm to reach them. If this block is cut out before the animal is matured, it may be possible to breed from her.

Another abnormality may lead to the production of infertile sperm. If both the testicles of the male remain permanently inside the body there will be no sperm produced. The nearer they approach the normal position in the scrotum the healthier will the sperm be. One descended testis is sufficient for fertilisation. Some maintain that this condition is always hereditary, and therefore the presumption is that a bull possessing a single descended testis will produce not only calves having a similar condition, but even some with neither testis descended. Whether this is always hereditary is certainly open to doubt, but that it frequently is so seems to be fairly certain, although it may be the result of an accident. In those countries, like ours, where stallions are licensed, it is worth noting that the number of rigs is decreasing. A daughter of a rig is just as likely as a son to transmit this character.

To be alive to the trouble is probably half the battle. A breeder should keep accurate records of the matings he makes. He should always keep his eye on the sire. While a sterile bull is perhaps more uncommon than a sterile cow, his use or otherwise in a herd may make the difference between profit and loss in the year's trading. Should the slightest suspicion rest on his fertility, the sperm should be examined. This can be done most conveniently by withdrawing some of the fluid from the vagina of a cow directly after service. Examination under a microscope would show whether or not spermatozoa are present, and, if so, whether they are vigorous and plentiful.

Should the bull prove in general to be a good stock-getter, then the blame rests with the cow. The suspicion that she is infertile owing to genetic reasons is the last one that should be adopted. The chances are rather that she has got some infection, or that her nutrition may be at fault. Only when these have been more or less disproved should it be considered that she is sterile because she was born that way. And then the sooner she is slaughtered the better. It must be remembered that " shy breeding " in the female can be transmitted by a perfectly normal sire.

To overcome sterility with artificial insemination may be attempted with the aid of a veterinary surgeon. It is unwise to adopt this practice should it appear at all possible that the sterility is due to a hereditary cause, for this will only lead to further sterility. It may, however, be used with advantage where the cause is mechanical or due to disease. Inability to retain service on the part of the cow (and, more frequently, the mare) may be counteracted by this means. In Russia artificial insemination is now an important factor in the improvement of the live stock of that country. Its application here awaits the discovery of some means of keeping the sperm fertile for a reasonable period.

Since certain forms of sterility can be inherited, it is only logical to assume that its opposite, fertility, may also be heritable. In pigs and sheep, this has been well demonstrated. The breeder should include fertility in his ideal of the perfect beast. It is not sufficient that he devotes attention to the fertility of the animals actually in his herd and under his observation. He must take into account the fertility or otherwise of their ancestors. Prolificacy in the cow, such as the bearing of twins or triplets, appears to be an inherited character. The bull to whom she is mated cannot cause her to be prolific, though by production of poor sperm he may limit the numbers she might produce. An instance of remarkable prolificacy in the cow has recently been recorded ; a roan Shorthorn produced thirteen calves in seven matings each time by a different bull.

The breeder of cattle does not want twins, for, if these are of opposite sexes, nine times out of the ten, the heifer is a " free-martin " and sterile. The breeder can, however, select for female stock which will take the bull regularly and for males which can be relied on to settle their cows. The results of such consistent selection should enable him to obtain a 95 per cent. calf crop which is a high degree of efficiency, provided, of course, that this selection is accompanied by an adequate control of disease and of nutrition.

As already stated, the percentage of fertility in the mare is extraordinarily low; only 50 to 60 per cent. of mares served in one year prove to be in foal. It has long been recognised that there is a big difference between one stallion and another as to the percentage of foals left. Data acquired by the Department of Agriculture for Scotland in connection with the administration of their premiums for stallions show that this difference is due to the hereditary constitution of the sire. It must also be recognised that some districts, such as the north-west of England, give consistently higher percentages than do others (Scotland and south-east England).

As compared with cattle and horses, complete sterility in the sheep is rare. Prolificacy is transmitted equally by the male and the female. Rams selected to sire breeding ewes should be twins rather than singles. Owing to the fact that a single lamb gets, as a rule, more milk from its dam than does a twin, there is a tendency for breeders to purchase such lambs at the sales. This tendency has, in certain breeds of sheep, led to a decrease in fertility. Where a tup is merely required to sire lambs none of which will be retained for breeding, it is immaterial whether he is a single or a twin.

Occasionally, statements are made that certain tups (and certain bulls), no matter to what female stock they are mated, tend to leave a high proportion of twins. Facts have been quoted which support this contention, and at least one example exists which shows that a hereditary factor exists. This may be so, and we must keep an open mind. But if it is the case, it is not easy to account for on the basis of our present knowledge.

There is no doubt whatever that prolificacy in the pig is inherited. But there is equally no room for doubt that litter size can be severely limited by the type of husbandry and nutrition : it depends also to a great extent on the age of the sow, and the season of the year. Size of litter increases up to the fourth farrowing and decreases after the sixth. It has been found by American writers that during winter months litter size is higher. In the production of a specified litter the boar, if he be normal and in good condition, may have little effect on the numbers produced by the sow. (There are, however, exceptions to this.) But he has an effect in every way as great as the sow on the size of the litters subsequently produced by the gilts of which he is the father. There has also been discovered a specific deformity in the reproductive organs of the boar. This is transmitted in a sex-linked manner. That is to say the sons of his daughters will show the defect.

Prolificacy in poultry is a factor of prime importance. Of recent years considerable progress has been made in the analysis of this problem from the genetic point of view. Too much emphasis cannot be placed on the value of trap-nesting and the egg-laying trials, which in Scotland are conducted under the auspices of the

Department of Agriculture. The most practical method of improvement, that of the progeny test, has reached its highest expression at the Mount Hope Farms in Massachusetts, and is one which should be copied by every breeder of pedigree poultry in this country. Where possible the cocks should be selected upon the performance of their daughters. With cockerels this is not possible, and these should be selected upon the performance of their full sisters, the question as to whether they are to be further retained in the breeding herd depending upon the productivity of their daughters. The commercial poultry breeder should endeavour to procure sires from trap-nested strains.

Pregnancy Diagnosis.—Incipient sterility can frequently be overcome if the breeder can, within a reasonable period, obtain some assurance as to whether or not his mare is in foal or his cow in calf. At the Institute of Animal Genetics, the University of Edinburgh, a test for pregnancy in the mare has been evolved which has a degree of accuracy of about 98 per cent. It is based on a biological analysis of the urine of the mare any time after 60 days from the date of service. A breeder desirous of availing himself of this test should communicate with the Institute when a bottle for the urine will be sent to him together with some simple instructions. To cover expenses a small charge of 10s. is made in respect of each mare. Workers in Missouri have evolved a similar test in respect of cows, but this does not give reliable results till 100 days after service, and has not yet been confirmed by workers in this country.

Conclusion.—The problem of sterility is of fundamental importance to the breeder of every class of live stock. The difficulty can be attacked from many angles, but the initial stages of every attack must take place on the farm. Prevention is better than cure. For this, elementary hygiene particularly at foaling and calving time must be practised and care must be exercised that in the addition of breeding stock to the farm the breeder is not purchasing animals affected with some disease. These two points cannot be too strongly emphasised. When an outbreak of disease does occur, the breeder is well advised to put his herd in the hands of a competent veterinary surgeon.

The nutrition and hereditary aspects of the trouble can only be tackled on the farm. To be alive to the difficulties and to be awake to their prevention is half the battle. The purpose of the present article is fulfilled if it is of assistance to breeders in an understanding of some of the principal factors which cause sterility. In a case of difficulty the breeder is advised to consult his veterinary adviser or county organiser who, if the case presents any unusual features, will be able to obtain the latest advice from the research institute or college primarily concerned. In Scotland there is a number of workers studying this problem from a variety of angles. Their experience, knowledge and advice are at the disposal of the breeder of live stock.

JUNIOR AGRICULTURAL CLUBS IN SCOTLAND

THE Young Farmers' Clubs movement originated in the United States of America in the early years of this century, and has since spread to most of the progressive agricultural countries of the world, where it is recognised as meeting a definite need in the education and training of young people in rural districts. It was not until 1922, however, that Clubs in Britain were started on an organised basis, and an article dealing with the organisation, aims and development of the movement in England appeared in the last issue of this *Journal*.[1] Considerable progress in the formation of similar clubs has been made in Scotland, particularly in the North, and it is interesting to note that, whilst the aim of the Scottish bodies is substantially the same as in England, the organisation and development differ in certain respects ; indeed these have followed somewhat different lines in the separate Scottish areas.

The movement in England has from the outset been subject to some form of central organisation and control. It was inaugurated by the late Lord Northcliffe at the time of the increased food production campaign in 1922 ; in 1924 the Ministry of Agriculture assumed responsibility for the provision of advice, appointed an organiser and gave direct support ; in 1928 the National Council of Social Service, with the financial support of the Ministry, undertook the central administration ; in 1929 a National Association to which clubs might affiliate was formed ; and in 1931 the present National Federation came into being. This Federation, with headquarters in London, has a staff consisting of a Secretary, a Chief Organiser and two Assistant Organisers, one stationed in the North of England and the other in the South-West. The majority of members of the Council of the Federation is formed of members of the clubs, elected by postal vote, the other members being either nominated by interested bodies, *e.g.* Ministry of Agriculture and Carnegie Trust, or co-opted. All clubs pay a small affiliation fee to the Federation. In some areas County Federations have recently been started, and have proved of value in co-ordinating the activities of the clubs in membership, each of which elects a representative to the Committee. There is thus in England an efficient system of supervision of the movement on a national basis, whereby the formation of new clubs, visits and advice to existing clubs, and the promotion of district and national activities are facilitated.

In Scotland, on the other hand, there is so far no national organisation. Assistance in the formation, organisation and work of Young Farmers' Clubs or Junior Agricultural Clubs forms part of the duties of the County Organisers attached to the three Agricultural Colleges, and these activities are carried on independently by the three institutions in the different College areas. In these circumstances there has naturally been some difference in the rate of progress, as well as in the form of activities, of the clubs in the respective districts. In the area of the North of Scotland College, where the first Young Farmers' Club in Scotland was started at Lanergill in 1923, the movement has made steady progress until there are now twenty-five clubs in existence with a total membership of about 500. It is also interesting to note that as a result of the establishment of Junior Agricultural Clubs in certain districts, the County Organisers have found a keen desire on the part of adults to form clubs on similar lines, and eight Senior Agricultural Clubs have now been formed in this area.

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[1] Young Farmers' Clubs. Prof. J. A. S. Watson, vol. xvi., No. 2.

A certain amount of difficulty has been experienced in initiating clubs in the West of Scotland Agricultural College area. This has arisen partly from the distances which often separate those who might become members of such clubs, and partly from the reluctance of young men fully in touch with farming operations and management to participate in a movement which may appear in any way juvenile. In addition, the other duties undertaken by County Organisers leave little time to devote to the fostering of a new movement. Nine clubs have been formed in the area with a membership of 98. In this area also Agricultural Discussion Societies have been formed at numerous rural centres, and these appear to meet with a readier response than do Young Farmers' Clubs.

The area of the East of Scotland College of Agriculture is devoted mainly to large scale farming, and there are relatively few closely settled agricultural communities, which provide the most favourable opportunity for establishing the clubs. The families of farm-workers, who constitute a large proportion of the rural population, do not have many opportunities for keeping live stock, and generally seem to lack the necessary incentive or ambition to avail themselves of club work in order to improve their technical knowledge of agriculture. Every encouragement and assistance in forming clubs is being given by the County Organisers in the area, and two clubs have recently been established with a membership of 40.

Another important point of difference between English and Scottish Clubs is the age limit for membership. The former are open to boys and girls between the ages of 10 and 21; in the latter the age varies in the different areas, and even in individual clubs in the same area. In the North, young persons of both sexes between the ages of 16 and 25 years are eligible (this explains the alteration in name from Young Farmers' Clubs to Junior Agricultural Clubs in this area); in the West the ages range from 15 to 23 years; in the two clubs in the East, the respective age limits are 10 to 20 and 9 to 18 years.

In view of the difference in the types and in the activities of the clubs in the three College areas, it is not possible to indicate the trend of development of the movement in Scotland as a whole;

but the following notes, referring to the work of the clubs in each area, may be of interest.

The North of Scotland College of Agriculture.—As has already been stated, the first Young Farmers' Club in Scotland was set up in 1923 at Lanergill, Caithness, at the instigation of the Caithness Advisory Committee of the College of Agriculture. The ensuing ten years have seen the movement spread steadily, and the College have based their oganisation on a system of Local, County, and Provisional Committees which will, it is hoped, lead eventually to the formation of a National Committee. In this area each County Organiser acts as a County Club Leader, in which capacity his principal duties are to aid the movement by propaganda lectures ; to select and organise local Club Committees, from which the Club Leaders are chosen; to aid and advise Local Club Leaders in the inauguration of local clubs, and in preparing schemes of club work; to co-ordinate club work in his county district, aid the instruction of club members, and report progress to his County Committee and the College ; to keep an official register of all clubs in his district ; to file copies of approved schemes of club work; and to assist with the educational work of the clubs generally. Each club is provided with a Constitution and Rules, and stress is laid on the proper conduct of all business at meetings. A programme of practical work in conformity with the seasonal operations of the farm is arranged at the annual general meeting, and each member must undertake one, and not more than two, practical subjects at a time. A record of the work is kept by each member and handed to the Committee at the end of the period. Normally, one of the subjects is undertaken by a majority of the club members for the purpose of inter-club competitions and exhibitions, but the selection of the second subject is left to individual members. Outdoor games and social amusements are also included in club programmes.

A summary of the programme of work carried out by two of the clubs during last year indicates the typical education and training young people are receiving through their club organisation.

In the first case, eight outings were held during the summer to different centres in the area, where inspections and demonstrations were carried out on Aberdeen-Angus, Shorthorn and Cross Cattle, Oxford, Suffolk and Border Leicester Sheep and Clydesdale horses, and also on plots of growing potatoes. Judging competitions were also held on each occasion. At the conclusion of the outings interest among the members was so great that the Committee of a local Agricultural Association have offered prizes at their Show in 1933 for the best single lambs of the three breeds mentioned above bred and exhibited by members of the Junior Agricultural Club. In the winter session lectures were given by prominent agriculturists in the district on a variety of subjects, *e.g.* a tour in America from an agricultural point of view ; rats, rabbits, rooks and farm pests generally ; manures, seeds, roots and general farm practice in the area; common diseases of farm animals; and a series of monthly talks on business methods and procedure at meetings was conducted.

In the second case, the summer programme included demonstrations, followed in each case by competitions for which marks were recorded, on such subjects as use of ropes (halter-making, splicing, etc.), stack-building, ploughing (care of plough, setting, etc.), hoeing, sheep-shearing and land surveying. Demonstrations at various centres of different types of live stock, turnips, oats and barley, followed by judging, were also given. The winter programme of lectures included such subjects as general management of breeding stock; grading of commercial stock and of prize animals; farm economy; care of implements; seeds and manuring. Each member of the club is encouraged to ask questions at demonstrations and lectures, and also take his turn of proposing votes of thanks to demonstrators and lecturers, and prizes are sometimes offered for the best address on a chosen subject given by a member.

There is enthusiasm for the movement in this area and the standard attained by the clubs is high.

The West of Scotland Agricultural College.—The most successful Young Farmers' Club in this area is in West Perthshire. It has been in existence for several years and has a membership of about forty. Originally organised for training in stock-judging, it has produced several highly successful teams, but its scope is now widening and demonstrations are conducted at selected centres where systems of farming are discussed and field experiments explained. Excursions to leading stock farms are also arranged.

The other clubs, seven in Lanarkshire and one in the Stewartry, are of recent origin, and their activities meantime are confined almost wholly to demonstrations on live stock and stock-judging. It is intended to extend the scope of the work to include simple agricultural experiments.

The East of Scotland College of Agriculture.—The two clubs in this area—one in Berwickshire and the other in Arbroath—are calf clubs similar in type to those so popular in England. The Berwickshire Club, started in January 1932, successfully reared ten Shorthorn heifer calves last year. Members met fortnightly to report progress. The County Organiser kept in close touch with the work and delivered periodical talks on topics such as calf-rearing, stock-judging, feeding of cattle, and identification of grasses. Visits to farms were arranged and the Club held a show in October. The members are enthusiastic, and have shown considerable initiative.

The Arbroath Club, which was inaugurated last year by the Arbroath Analytical Association and Farmers' Club, undertook the feeding and management of weaned Irish bull stirks purchased by means of a loan provided by a member of the parent Club. The animals were balloted for and distributed among the members, general guidance in their care being given by the County Organiser.

A show and sale of the stock was held in May of this year. In the present year it is intended to replace the feeding of older cattle by calf-rearing, and a considerable programme of talks and demonstrations has been planned by the County Organiser.

These brief notes on the position of Junior Agricultural Clubs in Scotland indicate that, while geographical and other difficulties may prove a handicap to rapid development in the eastern and western areas, there is scope for a great extension of the movement on the lines which have proved successful in the north. These clubs offer to young people in country districts a specialised training which the existing facilities for agricultural education do not otherwise provide, and an expansion of the movement would undoubtedly lead to an improved knowledge of agricultural practice and management, and to a wider and deeper interest in rural life generally. The Director of County Work of the North of Scotland Agricultural College writes :

" The key to a successful local Club is a keenly interested Local Committee of adults and an enthusiastic Club Leader. The County Organiser must of course be an enthusiast."

Given these essentials, the Junior Agricultural Club movement ought to wield an increasing influence in the education of young people in rural Scotland.

PINE : A DISEASE AFFECTING SHEEP AND YOUNG CATTLE[1]

J. Russell Greig, Ph.D., M.R.C.V.S.

Animal Diseases Research Association

The disease of sheep and young cattle known as "Pine" has been recognised in this country for at least a century. The condition is characterised by emaciation, lethargy and inco-ordination of gait, and usually terminates fatally. An early and full account is given by Hogg, the Ettrick Shepherd (1), who was a very acute observer on all matters concerning sheep husbandry. He observed that the disease generally affected all the sheep in a flock, but that in the great majority of cases recovery took place if the animals were changed to another type of pasture.

> "The pining is not infectious. Although the amazing rapidity with which it spreads among some flocks might lead to the conclusion that it was as contagious as fire, yet after

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[1] This article embodies the work described in the paper entitled "Pine : A Disease affecting Sheep and Young Cattle," published in *The Veterinary Journal* of March 1933, p. 99, by J. Russell Greig and Henry Dryerre, the Moredun Institute, Animal Diseases Research Association, Edinburgh, in collaboration with W. Godden and A. Crichton, the Rowett Research Institute, Aberdeen, and W. G. Ogg, the Macaulay Institute for Soil Research, Aberdeen.

> dear experience I am convinced that it proceeds wholly from the food ; because on land where it is but partially known and little regarded a straggling sheep will take it, and cling to its dry costive spot till it dies, and yet none of the rest be affected by it."

The disease appears to have caused serious ravages, and later, in his article, when describing scab, Hogg says :

> " I daresay it may have prevailed among sheep since Laban first stocked the mountains of Padanaram with them, and the patriarch Job took it into his head to lay 14,000 on the thirsty mountains of Uz : by the by, I do not wonder he lost them all, for I have little doubt it was the *pining* that came amongst them, and cut them all off."

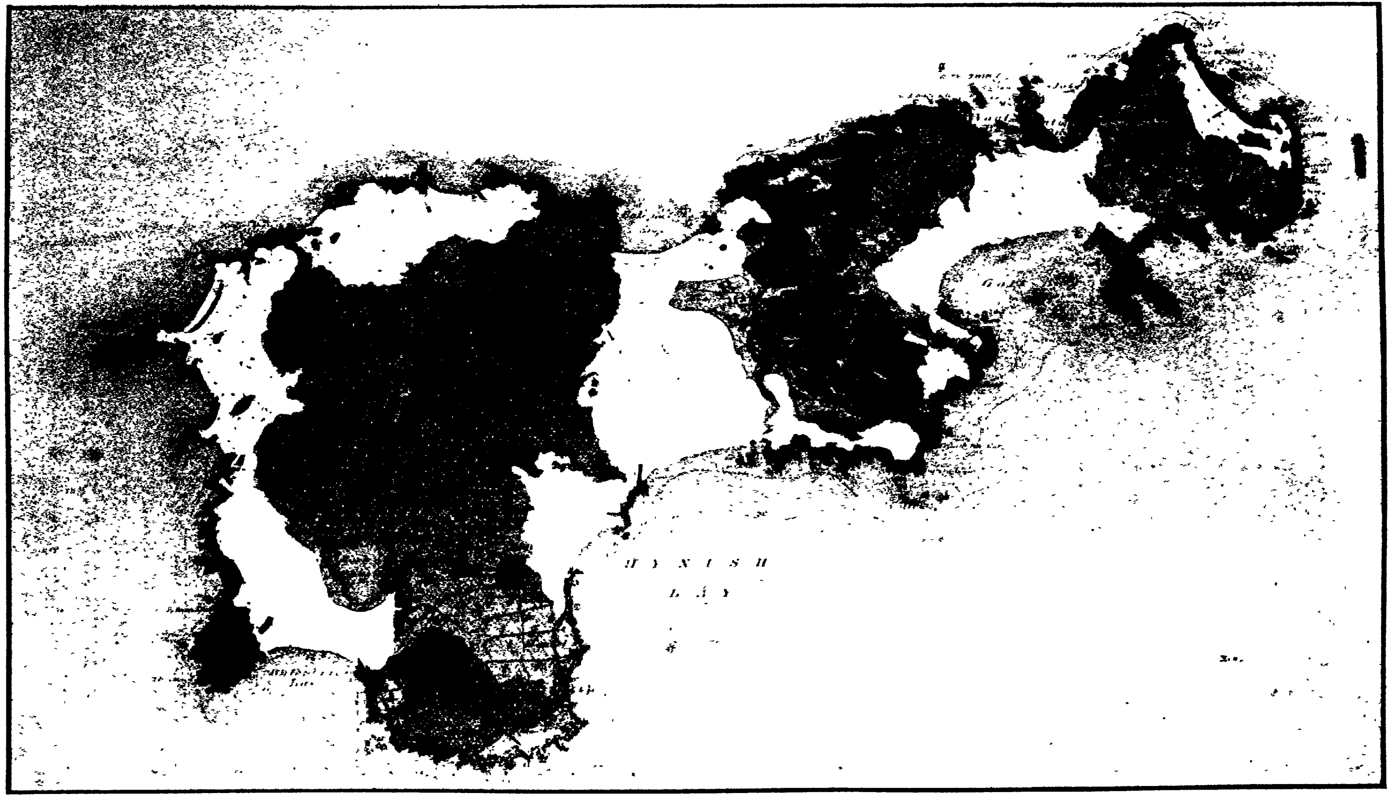
Since Hogg's time the condition has been recognised in many parts of the country, being variously known as " pining," " vinquish," and " daising."

M'Gowan and Smith (2) investigated the conditions of occurrence of " pine " on the northern slopes of the Cheviots, and they were able to confirm and elaborate the observations of Hogg. They found that the disease could be prevented by feeding the sheep on succulent pasture, or by folding them on a " break " of turnips. They suggested that the cause of the disease might be a deficiency of an accessory food factor, although it was realised by these authors that some of the evidence did not support this view. Conditions of wasting or pining in animals have also been observed in countries other than Scotland. Their wide geographical distribution has tended to obscure the fact that these diseases are similar in character. Thus, in New Zealand, sheep and cattle are afflicted with a disease known as " bush sickness," and the similarity of this condition to pine is commented upon by Godden and Grimmett (3). They refer to the work of Aston (4), who showed that pasture containing an abnormally low content of iron is the determining factor in bush sickness. On comparing the pastures from affected and non-affected lands, they found, in general, a lower content of iron in the former, and they refer to the fact that in the case of bush sickness the administration of iron and ammonium citrate elicited markedly beneficial results. The curative action of iron has also been observed in the condition known as " Nakuruitis," which is prevalent in the Nakuru district of Kenya. The animals, after grazing on the affected pasture for four to five months, become anæmic, emaciated and unsteady in their gait. The condition has been investigated by Orr (5), (6), who was able to show that the administration of licks composed of salt and ferric oxide effected a cure, and he is of the opinion that pine, bush sickness and Nakuruitis are closely related to one another. In Florida (7) a condition known as " salt sick " is recorded, and in this case also the administration of salt and ferric oxide together with copper sulphate was found to effect a cure. In all instances a change to non-affected pasture will prevent the disease, or, if it be already established, a cure can be effected if the change be made timeously.

Our attention was drawn to the acute condition of pine which occurs on the island of Tiree. This island, one of the Inner Hebrides, is 34 square miles in extent, and is treeless, low and flat. We are indebted to Mr J. Simpson, of H.M. Geological Survey, for the following short description of the geology of Tiree :—

> "Three clearly-contrasted types of terrain are present in Tiree. These are: (1) raised beach; (2) blown sand; (3) rock with little or no soil.
>
> "The *Raised Beaches* form ill-defined platforms, often interrupted by rock outcrops, at various levels up to 100 feet. The type of material in them is gravel, or gravelly sand. The individual sand grains are often rust-stained, and irregular iron-cemented layers or iron-pan have been noted in some pits. Raised beaches occupy more than a third of the total area of the island.
>
> "The *Blown Sand* forms extensive spreads on the raised beach at numerous localities along the seaboard where the coast line is low, and even extends in broad belts from sea to sea at the Reef, and between Gott Bay and Vaul Bay. The sand is in places heaped into low dunes, but for the most part forms comparatively flat grass-covered tracts. A very high content of shell fragments is a noticeable feature of the sand. Altogether, blown sand must occupy an area nearly as great as that of the raised beaches.
>
> "*Rock with little or no soil covering* forms the higher ground (above 100 feet) at Ben Hough, Ceann a' Mhara, Ben Hynish and near Scarinish, and also appears throughout the raised-beach area in numerous knobs and hummocks, varying in size from a few square yards to a few acres in extent. Geologically, the rocks are gneisses of various kinds, for the most part of an acid or sub-acid nature. Basic types are also present, but are of less importance. Limestone (marble) and lime-rich gneisses are also present, and rocks of this nature are believed to underlie the Reef and a part of the Gott Bay-Vaul Bay area. It is not considered, however, that in these areas the underlying solid rocks will affect the surface soil, as it is most probable that raised-beach deposits intervene between the solid rock and the blown sand."

It has long been recognised that although the pasture on Tiree is luxuriant, when sheep and young cattle are grazed continuously upon certain parts of the island, especially the areas of blown sand, a number is liable to become affected with pine. If, however, at the end of three or four weeks the animals be shifted from these



Map of Tiree
The light portions represent the areas of Blown Sand on which Pine occurs. The shaded portions refer to the Raised-Beach areas (see text).

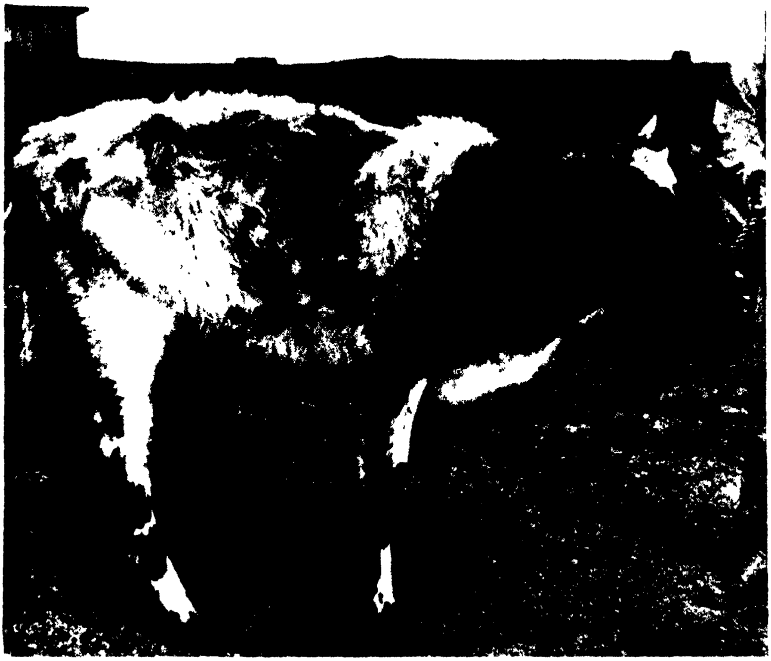


FIG. 1.—Control Animal No. 251 at end of experiment, showing typical symptoms of "Pine."

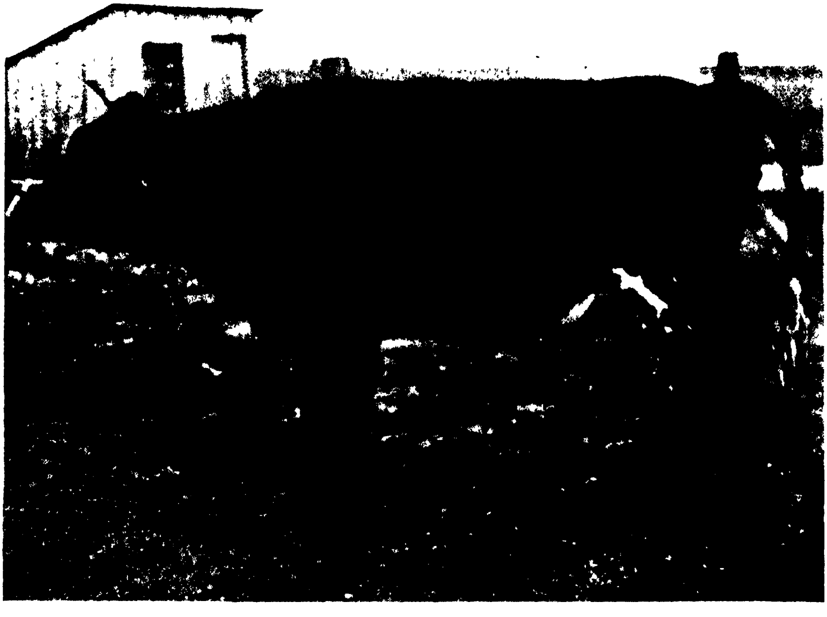


FIG. 2.—Treated Animal No. 266 at end of experiment, showing complete recovery. At the commencement of the experiment this animal was the most severely affected of any in the three groups.

"thriftless" areas to parts of the raised-beach terrain for a fortnight or so, they can again be grazed safely for another period of three or four weeks upon the affected pastures. In other words, so long as a shift is made at intervals of not more than three or four weeks, the animals appear to thrive as well on one type of grazing as on another. This fact suggested that a dietetic deficiency existed upon the affected grazing.

As evidence that the condition has been recognised from early times, and that the need for shifting grazing animals has long been appreciated, it is interesting to observe that the ancient crofts on the island were so disposed that periodic shifts from the blown sand to the raised-beach areas could be readily effected.

Although, as has been indicated, the early symptoms of pine can be noted after a period as short as three or four weeks, more commonly the symptoms develop only after the animals have been grazed continuously on the affected pasture for a period of two to three months.

In 1930, we resolved, in collaboration with the Rowett Research Institute and the Macaulay Institute for Soil Research, to investigate the nature of pine as it occurred in Tiree, and during that grazing season samples of grass from the Reef, that is, "thriftless" pasture, and samples from the raised beach, that is, a "non-pine" area, were collected and analysed at the Rowett Research Institute. It was found that in each set of samples there was considerable variation between the different grasses off the same soil. On the whole, the grasses off the Reef were poorer in nitrogen and phosphoric acid, but richer in soluble ash and lime than those off the raised beach. Subsequently, composite samples of the herbage on the two types of soil were collected at approximately monthly intervals. As in the previous set, it was found that the samples off the Reef were poorer in nitrogen and phosphoric acid, but were richer in lime, than the corresponding samples off Hylipol, a "non-pine" area; but in this set they were poorer also in soluble ash.

In both sets there was an increase in the lime-content of the herbage as the season advanced, but as regards phosphoric acid, there was a slight increase in the case of the Reef samples, but a decrease in the case of the Hylipol samples. The iron was not estimated in these samples owing to the contamination of the herbage with soil. This contamination might also have slightly raised the lime-content of the herbage from the pine area owing to the high lime-content of the soil, but the effect would not be very great, and not at all comparable with the effect on the percentage of iron in the herbage. For the purpose of comparison it may be observed that the last samples of the pasture from the raised-beach area compared favourably with the average composition of Scottish hill pasture, as found by Godden (8).

The symptoms of "pine," as it occurs in Tiree, are those of a progressive debility, accompanied by anæmia and emaciation. The onset is frequently insidious. The affected animal is dull, and the coat, in the case of cattle, is rough and staring ; the visible mucous membranes, especially the conjunctiva, become pale ; physical condition is gradually lost, the eyeball becomes sunken, and there is commonly a serous discharge from the eye. In young animals growth is markedly retarded, and they soon present a stunted, unthrifty appearance. Thereafter the anæmia and emaciation progress, and, finally, as the result of extreme weakness, the animal is unable to rise. In severe cases the gait is stilted and somewhat inco-ordinated.

Since, as has been mentioned, the clinical symptoms of pine in Tiree presented a marked similarity to those of bush sickness and Nakuruitis, and since these diseases had been shown to respond to the administration of iron, it was decided, after consultation with Dr J. B. Orr, to carry out a field experiment during the 1931 grazing season in order to test the effects of rationing supplementary minerals. Accordingly 21 young island cattle of nondescript breeding were purchased. These animals averaged about 3 to 4 cwt. in weight, but since no weighing facilities were obtainable on the island, their weights were not definitely determined. Some of these animals had been bred on pining areas, and the early signs of pine were actually in evidence. The 21 cattle after inspection were numbered by ear tags, and divided into three groups of seven, care being taken that each group was closely comparable with the others, according to the place of origin, breeding, size and condition. Samples of blood were then withdrawn from each of the animals and submitted to a comprehensive chemical analysis. This was carried out by Professor Henry Dryerre, Chief Bio-chemist, the Moredun Institute.

It was found that the physical condition of the animals ran almost *pari passu* with the hæmoglobin content of the blood, the greater the amount of the hæmoglobin, the better the physical condition.

All three groups were put to graze in fenced enclosures on the "pining" land. *Group I* was retained as a control group. *Group II* received a mineral allowance consisting of sodium chloride, 1 oz., and ferric oxide, 1 oz., per animal per day. *Group III* received a daily mineral mixture consisting of sodium chloride, 1 oz., ferric oxide, 1 oz., dicalcium phosphate, 1 oz., per animal. A quantity of sugar beet pulp was also mixed with the minerals in order to render them palatable. All the animals of each group had free access to a common drinking-trough.

Since, as has been indicated, there were no facilities on the island for weighing the animals, their progress could not, therefore, be followed by that means. For economic reasons, it was impracticable to visit Tiree periodically for the purpose of obtaining blood specimens, and it was therefore decided to allow the experiment to run for about three months, and then to return to the island for the purpose of assessing the general condition of the animals, and of obtaining further specimens of blood. At the end of twelve weeks the island was revisited, and the same procedures as on the former occasion were carried through.

The respective physical condition of the three groups of animals was assessed, and it was found that although the physical condition of the animals in Group I differed considerably from that in Groups II and III, the physical condition could not be correlated with the hæmoglobin content of the blood. In Groups II and III, which had received respectively crude iron oxide and crude iron oxide plus dicalcium phosphate, all the animals were thriving satisfactorily, and in these groups the animals which, at the commencement of the experiment, were actually suffering from pine, were now completely cured. On the other hand, all the animals in the untreated group showed a harsh skin and a staring coat, with the exception of one which appeared to be progressing favourably. One animal, No. 251, of the untreated group which was suffering from pine at the commencement of the experiment, was now found to be very severely affected (Fig. 1). No. 266 of Group III, which, at the commencement of the experiment, was more severely affected with pine than any other animal of the three groups, but which had received the iron ration, was now thriving and healthy (Fig. 2).

On this occasion, we had, in addition, the assistance of Mr John Wilson, County Organiser to the West of Scotland Agricultural College, as an independent observer, and he had no difficulty in distinguishing the treated from the non-treated animals.

During the course of the experiment, the soils from non-pine and the pine areas were examined at the Macaulay Institute for Soil Research, and Dr Ogg reported that in the soil from the pine area there was a large proportion of calcium due to the preponderance of shell fragments as compared with the soil from the non-pine area. The iron-content in the pine area was lower than that in the healthy ground, and this lessened quantity of iron was rendered the more significant because its availability for the pasture plants was limited by the large amount of calcium in the soil.

Discussion.—Although, as is well known, the growing plant needs only a very small quantity of iron for its requirements, the factors which govern the availability of this iron for the grazing animal are imperfectly understood, and our knowledge of the metabolism of iron in the animal body is still very limited. It appears, however, that certain areas of grazing land, such as those in Tiree, are markedly deficient in available iron.

It is probable that many extensive iron deficient areas occur throughout Scotland. A limited number of experiments with pining animals in such areas has already demonstrated the markedly curative effects of iron administration.

It is, however, to be understood that many conditions of progressive debility in sheep and cattle are unassociated with iron deficiency, and do not, therefore, respond to iron administration, and the location and extent of the iron deficient areas remain to be determined.

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THE SHEEP TRADE POSITION

H. G. MILLER, B.SC.

Rothamsted Experimental Station

SHEEP prices have recently been one of the few reasonably bright features in the agricultural markets and about the only one as far as Scottish agriculture is concerned. Many would like to know the reasons for this, and still more would willingly learn of the chances for a continuance of this state of affairs. Prophecy is indeed risky, and at no time more than the present when factors, wholly or largely political, are so prominent. In addition to the Ottawa agreements, voluntary restrictions on imports, trade agreements with other countries, and marketing schemes, it is the Government's declared policy to encourage the rise of wholesale prices. Exchange fluctuations, and the deliberate depreciation of the exchange rate by certain countries no longer tied to gold, are also important. The present rate of exchange, for instance, encourages Australian and New Zealand exports. Factors like these can transform the situation in the few weeks elapsing between the writing of these words and their appearance in print. But one can at least examine the present position and some of the diverse factors influencing the sheep trade. This examination, considered along with any further effects of government action, may help to throw light on the present situation and on future prospects.

The steady decline in prices since 1931, with its ruinous conclusion last autumn, cannot be ascribed to any individual cause. The recent recovery, likewise, is due to several factors. It would be of great value to be able to determine with some precision their relative importance. Dr Keith Murray, in his book, *Factors Affecting the Prices of Livestock in Great Britain*, made this attempt with considerable success for about 40 pre-war years, as well as for a short post-war period from about 1924 to 1929. He showed, for instance, that the price (or more accurately, the " purchasing power ") " of first quality mutton in Great Britain moved in close relationship to the numbers of sheep in Great Britain," while total imports of mutton and lamb had little effect on this price, a noteworthy point. Changes in the level of wages in industry were important. There seemed to be " a relatively stable demand for what is, after all, the highest priced meat." The demand for secondary qualities was affected much more by changes in the level of wages, and probably also by changes in the quantities of imports. Changes in our sheep population had only quite small effect on the price of this class.

The various factors involved certainly have different degrees of importance according to the quality of the home article. But the new conditions which have arisen since 1930 must have disturbed to some extent the importance of factors whose effects had previously been measurable. Further research may yield information on this point, although at present it is difficult to see how any method of statistical analysis can cope with exceptional and non-recurrent factors acting over a short period of time, or with the steadily increasing effects of government policy on the various departments of British agriculture.

At present, in considering prime quality mutton, which is our chief interest, it seems reasonable to arrange the different factors somewhat in this order of descending importance :—

Changes in the sheep population in Great Britain.
Varying quantities of imports.
Changes in the purchasing power of wages, particularly the reduction in middle-class incomes, and also the general depression, although, in so far as this has led to an all-round reduction in world prices, it has not decreased the " purchasing power " of mutton.
Competition of other classes of meat.

Up to 1931, fat sheep remained consistently dearer relative to the general price level of agricultural produce. Taking both this level, based on a large number of different products suitably weighted, and the price of fat sheep, as 100 for 1911-13, the figures (or "index numbers ") since 1926 are :—

	1926	1927	1928	1929	1930	1931	1932
Fat sheep . .	157	150	167	157	160	133	97
General level .	151	144	147	144	134	120	112

Similar figures for recent months, including store sheep, are as follows, the 1911-13 prices for each month being taken as 100 :—

	1932							1933				
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Store sheep . .	98	90	81	80	72	70	72	83	82	85	84	84
Fat sheep . .	107	97	90	86	83	87	91	107	106	112	116	120
General level . .	111	106	105	104	100	101	103	107	106	102	105	102
Fat sheep 1911-13. Av. price per lb. dead wt. in pence.	7¼	7¼	7¼	7¼	7¼	7½	8	7½	8	8¼	8	7½

Thus fat sheep prices during the last three months have for the first time since October 1931 reached a figure appreciably higher than the general level. These figures would also seem to indicate that fat sheep prices since January have been less a cause for surprise than those during last summer and autumn. These prices appear now to bear a more reasonable relationship to the general level and may therefore be in a less unstable condition. An examination of the index prices of mutton since 1930 indicates that the present position is reasonably hopeful.

Let us consider now the main factors affecting the sheep position.

1. **The Sheep Population in Great Britain.**—The sheep population for England and Wales sank from 22 to 17 millions (of which 7 were ewes) in the forty years before the war. Since the war, the number of ewes increased from 5 millions in 1920 to 7 millions in 1927; there was a slight drop to 1929 and a sharp rise since. In Scotland the increase has been less but very steady. Taking both countries together, the sheep population in 1932 was the greatest since 1911, and the number of ewes the highest recorded since they were first regularly enumerated in 1893.

The actual figures in thousands are:—

	England and Wales		Scotland		
	Breeding Ewes	Total Sheep	Breeding Ewes	Total Sheep	Combined Total
1911-14 .	7,039	17,943	2,959	6,999	24,942
1920 . .	5,108	13,383	2,756	6,361	19,744
1927 . .	6,962	17,072	3,239	7,535	24,608
1928 . .	6,847	16,399	3,275	7,579	23,978
1929 . .	6,717	16,105	3,281	7,556	23,661
1930 . .	6,811	16,316	3,325	7,650	23,965
1931 . .	7,262	17,749	3,415	7,831	25,580
1932 . .	7,634	18,479	3,442	7,916	26,395

These figures in themselves are sufficient to explain a fall in price, and people studying the trend of sheep populations in this and other countries had for some years been expecting this fall. But nobody, probably, had expected the fall to reach the depths of last autumn. In previous years, Dr Murray had shown that when the total sheep population in Great Britain was 10 per cent. above normal, the purchasing power of prime mutton was 13 per cent. below normal. The recent rise in sheep population has been less than this, but the fall in purchasing power distinctly greater.

Sales of Fat Sheep.—The increased sheep population in Great Britain is reflected in the increased numbers of fat sheep passing through the markets. Taking the representative markets of England and Wales appearing in the Ministry of Agriculture's Statistics (slight alterations were made in the markets classified during the first period of the following table), and certain selected Scottish markets, the figures are (for 51 weeks) :—

	England and Wales	Scotland
1924-28 . .	1,760,000	380,000
1930 . .	2,080,000	435,000
1931 . .	2,024,000	451,000
1932 . .	2,248,000	523,000

Several points emerge from the study of these figures and their monthly sub-totals.

(1) The increases in numbers are remarkable, the rate being considerably greater than the rate of increase in sheep population in the same time. In Scotland this is due chiefly to the natural business growth of the few markets examined, but in England it probably indicates that the practice of direct sale to butchers, so encouraged by war-time regulations, is somewhat less prevalent now than it was about 1924.

(2) Much larger numbers of fat sheep (or lambs) are put on the market in the spring as well as in the autumn. Taking the English and Welsh markets already mentioned, the actual numbers of fat sheep (or lambs) passing through in the last five months compared with the first five in the following calendar year have been as follows, in thousands (adjusted in some cases for Foot-and-Mouth Disease restrictions) :—

	Aug.-Dec. (21 wks.)		Jan.-May (21 wks.)
1924-26 .	814	1925-27 .	717
1931 .	874	1932 .	793
1932 .	999	1933 .	887

A study of the index numbers of prices shows too that, in addition to the seasonal fluctuations already existing in 1911-13, new seasonal effects are acting. The autumn slump is now greater, the result of these increased numbers of sheep, while the market has been better able to absorb the increased numbers from January to May, an increase that has gone on steadily each year since 1924, except for a drop from 832,000 in 1930 to 752,000 in 1931.

As is also well known the acreage of roots for stock has been steadily declining, and this decline still continues unbroken. Actual figures, in thousands of acres, are :

	England and Wales	Scotland
1909-13 . .	1972	585
1923-27 . .	1156	397
1930-31 . .	923	368
1932 . .	809	350

We thus have the paradoxical situation in both countries that winter and spring fattening of sheep increases while the root acreage decreases. This may be due to sheep receiving a greater proportion of the roots grown, at the expense of fattening and other cattle, to the use of smaller rations of roots and the greater use of grass, and, in England, to the increasing use of sugar-beet tops and pulp. Definite information on these speculations would be valuable.

(3) The numbers of fat sheep marketed between August and December have increased, but their proportion to the annual total, though greater now than before the war in England, has not increased during the last few years—that is, on the fairly safe assumption that the number of sheep sold privately bears a steady proportion to those sold in these representative markets. In England about 42 per cent. of the total number sold fat annually (June-May) has been marketed between August and December in recent years, but the proportion undergoes more seasonal variations than in Scotland where it has been about 41 per cent. In neither country does this figure show any consistent tendency to rise. Figures for the last three months and the first three of the calendar year tell the same story. It thus seems wrong to ascribe recent intensification of the annual autumn slump, as far as fat sheep (or lambs) are concerned, to a greater *proportion* of the total being marketed at that time, or, to any notable extent, to the reduced root acreage.

The slump in 1932 was evidently due to neither of these causes.

(4) In every month of 1932 more fat sheep were sold than in 1931, the figures from June to November being particularly high. In January and February 1933 for England they were about 10 per cent. above the corresponding months last year, and these high figures have continued to the end of May. Despite this, demand continued brisk. The market has readily absorbed quantities which would have caused a glut in the same period in 1932. Can we find a solution to this puzzle in a study of imports ?

2. **Imports of Mutton.**—Changes in the consumption of mutton in Great Britain, including home production, are shown very clearly in the Ministry of Agriculture's Report on the Marketing of Sheep. This next table is derived from that Report and brought up to date by information kindly supplied by the Ministry.

Year (June-May)	Home Production (1000 tons)	Net Imports (1000 tons)	Total Supplies (1000 tons)	Consumption per head of population
1911-14 . .	271	283	554	30·1 lb.
1926-27 . .	234	294	528	26·8 ,,
1927-28 . .	261	293	554	28·0 ,,
1928-29 . .	251	304	555	28·0 ,,
1929-30 . .	239	331	570	28·6 ,,
1930-31 . .	220	352	572	28·6 ,,
1931-32 . .	249	372	621	30·9 ,,

The chief point in the table is the big increase in imports, bound to affect prices adversely, for which Australia and New Zealand are chiefly responsible. Wool production being so important in Australia, it is suggested that the big increase in Australian exports is the result of a reduction in flocks, following the slump in wool prices. The Australian sheep population reached a peak of 107 millions at the end of 1930, 2 millions over the previous year and the highest on record. But Australia is also deliberately developing its fat lamb trade.

Australia, New Zealand, Argentina and Uruguay are our chief sources of imported lamb and mutton. Imports from Australia have fluctuated very widely in the past. Half a million cwt. in 1921 followed 2¼ million in 1920. Since 1924 imports have risen fairly steadily from about ½ million cwt. Imports from New Zealand have increased very steadily from 2¼ million cwt. in 1923 (after nearly 4 million in 1921) to 2¾ million in 1929, while from Argentina they remained at about 1½ million cwt. from 1921 to 1929 ; now they are falling. So are imports from Uruguay. Actual figures for the last three calendar years are, in 1000 cwt. :—

	Australia	New Zealand	Argentina	Uruguay	Total (including other countries)
1930 .	810	3292	1452	423	6385
1931 .	1529	3470	1553	284	7107
1932 .	1156	3916	1386	164	6964

The sheep populations of probably all these countries are now falling. In New Zealand it has declined by over 2 millions since 1930 (6½ per cent.). Throughout Europe, too, the general trend has been downward for a good many years, and there is no evidence yet of any change ; the general development of European agriculture is not in favour of an increase. On those grounds alone, the situation as regards imports now seems more hopeful.

Australia and New Zealand, however, do not share this view as to the natural decline of their exports through the decline of their sheep population. For the purposes of the Ottawa agreements Australia expected no decrease on the high figure of 1490 thousand cwt. reached in the year 1931-32 (July to June), while New Zealand expected a slight increase in the present year and a 5 per cent. increase in each of the two following years. The Ottawa agreements ensure that the present fall in imports from foreign countries will continue, but this is cold comfort when New Zealand and Australia together are responsible for about three-quarters of our total mutton and lamb imports.

The maximum permissible total imports for 1933-34 are 6883 thousand cwt., a reduction of 6 per cent. on the 1931-32 figures,[1] and back to the 1930 level, but, unless Australasian currencies remain depreciated in terms of sterling, it would not be surprising to find that other causes prevented this figure from being reached.

In the last quarter of 1932, imports into Great Britain amounted to 63,000 tons, against 81,000 in 1931 but 58,000 in 1930. The fall in imports was already marked before the voluntary import restrictions came into force, possibly in an attempt to keep off such a bad market as ruled then. This theory may be the complete explanation of the rise in imports this spring, when, for the first quarter, they reached 1802 thousand cwt., the highest figure yet recorded for that period. The smaller figures for April support this theory, but there is an ominous increase in those for May, for which Australia is almost entirely responsible.

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[1] K. A. H. Murray : *Occasional Notes, Agric. Econ. Res. Inst., Oxford*, Oct. 1932.

Just after the introduction of the voluntary restrictions there was an unexpected and drastic fall in imports from New Zealand, as follows (in 1000 cwt.) :—

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1931-32 .	225	138	175	100	275	416	473	419
1932-33 .	159	215	63	116	271	457	447	397

This, along with the big fall in total imports in the last quarter of 1932, must have played some part in helping the recovery of prices. The market has been able to stand a supply of 3061 thousand cwt. of imports in the six months, Oct. 1932 to Mar. 1933 along with a bigger home supply, considerably better than 3262 thousand cwt. in the same period a year ago.

Thus the reduction in imports does help to explain the early spring rise in home prices, but, despite the powerful effect of small gluts and shortages, probably it does this only partially. Increased demand is scarcely likely to be another factor just now ; so perhaps, after deducting the normal seasonal rise, we can give government action, with its psychological effects, the credit for the remainder, although similar action appears to have had no effect on beef prices.

In some respects the situation this spring recalled that in spring, 1928. Then, too, there was a brisk demand for fat sheep although the supply, as at present, was larger than in previous years. There was a steep rise in price, more marked than this year, from February to May, and an equally steep fall back to the February level by August. Imports of both beef and mutton were then lower than they had recently been, but bacon supplies were heavier. There was nothing like the present industrial depression and thus the demand was also brisk for fat cattle.

If the full quota of imports allowed by the Ottawa agreements comes in, and home production maintains its present level, the outlook with the present restricted demand is not bright. But under healthy demand conditions there should be no fear of overproduction. Since our human population is now greater and our *per capita* consumption of mutton is scarcely greater than it was pre-war, that consumption should increase as the standard of living rises. In the course of time, too, markets may develop on the Continent where the *per capita* consumption is at present very low.

3. The Effect of Other Classes of Meat.—In a recent article in *The Times*, Sir Wm. Haldane suggested that continued low prices for cereals were stimulating attempts at marketing them less unprofitably. They were being converted into live-stock products, chiefly pork and bacon, and this constituted a danger to the future improvement of live-stock prices. Sir Wm. Haldane believed this to have been an important factor in lowering meat prices during the present depression, a view also expressed by other authorities. Yet bacon is generally considered a breakfast food, filling a different and non-competitive role to that of mutton. Nevertheless, in face of the recent abundance and cheapness of both bacon and pork, it is difficult to disprove their effect on other meat prices. There has also been a weaker continental demand for meat, which, presumably, may have led to the diversion of additional supplies to these shores.

Low prices for one class of meat do not necessarily pull down others. For instance, from 1924-25 to 1930-31, the index number for fat sheep was consistently above that for fat cattle, generally by more than 20 points. From the end of 1931 to January 1933 cattle were relatively better than sheep. They came equal in February and now sheep lead again. The index number for pork pigs has been practically equal to that for fat sheep this year, and bacon, which started lower, has recently been approaching the same level. There is, of course, no reason for expecting the relationship between these prices to be exactly the same as it happened to be in 1911-13.

Different factors are of varying importance in their effects on the prices of different classes of meat. Beef is more readily affected by bad industrial conditions and lower purchasing power of wages. Thus, in spite of steadily declining imports and lower home production, its index number is once again below that of mutton, although, until May, no lower than the 1911-13 price level, despite complaints as to its lowness. Mutton, which is consumed chiefly by the middle and upper classes, is regarded as more of a luxury article than beef. The recent fall in the incomes of these classes would thus weaken the demand for mutton and lamb, although the amount of the reduction in retail prices did not indicate that demand was much weaker. These incomes have not risen in the last few months, so that the consumers' demand is unlikely to be greater now than it was. Plentiful supplies may, however, have increased the taste for mutton amongst the population.

The following table, based on one drawn up by Sir Wm. Haldane and brought up to date with figures supplied by the Ministry of Agriculture, shows the position of all meat supplies (in 1000 tons):—

	Beef and Veal			Total Beef, Veal,	Pig Products			Grand
	Imported	Home	Total	Mutton and Lamb	Imported	Home	Total	Total
1911-14	595	620	1215	1769	333	268	601	2370
1925-26	805	598	1403	1905	476	282	758	2663
1926-27	796	594	1391	1919	475	243	718	2637
1927-28	754	634	1388	1942	538	294	832	2774

	Beef and Veal			Total Beef, Veal,	Pig Products			Grand
	Imported	Home	Total	Mutton and Lamb	Imported	Home	Total	Total
1928-29	742	637	1379	1934	515	326	841	2775
1929-30	732	647	1378	1948	511	256	767	2715
1930-31	722	606	1328	1900	609	254	863	2763
1931-32	705	577	1281	1902	672	303	975	2877

Total meat consumption per head of population, 1911-14, 128 lb.; 1931-32, 143 lb.

Total meat supplies remained remarkably steady for the six years prior to 1931-32. Increases in certain categories offset decreases in others. But in 1931-32 there was a distinct jump, due entirely to increased supplies of pig products.

The Ottawa agreements are based on the belief that the price levels of different classes of meat affect each other.

4. **Conclusion.**—It seems from considering this medley of interacting factors, that the autumn collapse of fat sheep prices was due to the unfortunate combination, and in some cases intensification, of a number of adverse factors. Markets were still feeling the effects of recent heavy imports of mutton, which had already exerted a weakening influence on home prices, when extra heavy home supplies, no more than the natural result of increased production, were coming on to them; demand was poor; there was an over-abundance of pig-meat, and the general price level was still falling.

The store and breeding market suffered in sympathy with the fat. Under such depressed conditions fewer English farmers felt disposed to make their usual purchases at the Scottish autumn sales.

Lower imports, and particularly the sudden New Zealand drop, aided by the normal seasonal advance in prices, and possibly by government action with its consequent psychological effect, were probably the chief factors in bringing sheep prices back to a more normal level relative to other agricultural products.

As for the near future, a combination of adverse factors next autumn, similar to that of 1932, would be surprising. The chief factors likely to affect the position then and later can be divided into two classes; those which encourage optimism and those which do not. Unfortunately the latter are the more numerous, though possibly not the more powerful.

The principal hopeful factor lies in the probable continued reduction in imports of mutton and lamb. If the natural tendency is more effective than agreements in restricting imported supplies until general economic conditions become more healthy, the market should then be able to absorb the agreed quantities. Reduced imports of other classes of meat also raise slight hope, while other official action, such as the development of marketing schemes, may eventually prove beneficial.

There are certain other factors, however, which must be taken into account. Reduction in imports of all classes of meat is no certainty. Our own sheep population is at a high level, which ought really to be a matter of rejoicing particularly to those supplying breeding stock. Now that we have regained the pre-war level of production, it will be a pity if circumstances force a reduction in our flocks. Again, the world depression persists, with its consequent adverse effect on the purchasing powers of the mutton-consuming classes. Lastly, we have not yet solved a whole series of production problems in this country, a most important factor if we take a longer view. There is still the problem of autumn gluts. It has been suggested that import restrictions should be increased during the period of the seasonal autumn glut of home meat supplies, and this would undoubtedly be of very material assistance to the trade. There is also the problem of the economic production, throughout more districts, of the small carcases in present demand, particularly during the period from January to April. Public tastes will change despite import restrictions. We must strengthen our hold on the market lest some day import restrictions are swept away. Happily there is every sign that producers are sparing no efforts to modify their methods to suit changed tastes wherever there is a reasonable chance of profit.

The outlook cannot be called particularly bright, although there are grounds for a certain reasonable optimism. The annual weakening of price is bound to occur to some extent when the bulk of this season's grass-fed lambs are being marketed, and their numbers may be slightly swollen by an increased, though still relatively small, number of Irish lambs. But this should not prevent the autumn store and breeding stock sales from being distinctly better than last year. The changed outlook, given weather conditions reasonably favourable for grass and roots, is likely to revive the English demand, one of the most hopeful factors in the Scottish sheep raisers' prospects. Grass ewes are still increasing at the expense of arable flocks in the south. The Half-bred has won a prominent place on its own merits without propaganda, apart from that resulting unconsciously from the practice of Scottish farmers who have settled in England. Propaganda could doubtless increase the demand further, although there is a possibility that the attempts to rear suitable ewe lambs in the districts where they are wanted may result in the future in the English farmer finding it less advantageous to go so far afield to keep up his flocks of grass ewes. There is also room for the capture of new trade. It should be possible to produce hardy and prolific grass ewes which would lamb in the late autumn, and these might well replace the flocks of Hampshires of low fertility still so widely used in the production of early fat lamb.

THE CONSTRUCTION AND EQUIPMENT OF CATTLE BYRES

II.—Automatic Drinking-Bowls

ALEXANDER BURN FOWLER, B.SC.

The Hannah Dairy Research Institute, Kirkhill, Ayr

SINCE approximately three-quarters of the animal body consists of water, the need for a generous supply of drinking-water for all classes of stock is apparent. Briefly the chief functions of water in the body may be summarised as follows: First, to allow the nutrients of the food to be assimilated in a liquid condition; second, to form the basis of the medium in which these nutrients are distributed to the body cells; third, to enable the cell contents to maintain their fluid condition, and in certain instances to produce specialised secretions (*e.g.* milk); and fourth, to act as an eliminating agent for waste or poisonous products formed in the body.

So far as dairy cows are concerned, there are two main factors which influence water consumption. In the first place, since milk contains about 87 per cent. water, it is obvious that the water requirement will depend largely on whether the animal is dry or lactating, and, if lactating, on the amount of milk produced. It is generally recognised that a dry cow will require not less than 5 gallons of water per day, while for lactating animals the requirement per gallon of milk has been variously estimated at from 3½ to 5½ gallons per day. In the second place, the amount of actual drinking-water required will obviously be influenced by the moisture content of the ration fed. Thus cows fed on roots or on moistened feeds will require proportionately less drinking-water than those given dry feeds.

On the majority of dairy farms it has in the past been customary to allow the cattle access to water only once or twice per day. The present tendency towards concentration on high milk yields, with the resulting increase in the water requirements of milking stock, has, however, led to the development of the more rational practice of allowing animals constant access to water. Thus a cow giving 5 gallons of milk per day may require as much as 25 gallons of drinking-water per day—a quantity which, if drunk in only two draughts, would not only be inconvenient, but probably detrimental to the health and digestive processes of the animal.

So long as cows are at grass no difficulty should arise in providing adequate quantities of water, partly because of the high moisture content of the grass itself (which contains as much as 80 per cent. moisture), and partly because the cattle can have free access to field water-troughs. During stall feeding, however, the animals are usually receiving relatively dry feeds, and lack of freedom prevents access to drinking-water. The provision of some form of automatic water-supply for stall-fed animals is therefore essential.

The earliest practice was to fit a constant level drinking-trough along the front of each row of stalls. This method has, however, been quickly superseded, on the grounds of cleanliness and general hygiene, by various systems of individual drinking-bowls in which the water is supplied independently to each stall or pair of stalls. Many types and designs of drinking-bowl are at present on the market, but little information appears to be available as to their relative efficiency. During the past three years the author has therefore carried out an extensive series of trials on drinking-bowls of widely varying types and construction, with the object of determining the more important points which affect their utility. On the basis of these trials, the following notes have been compiled for the information of manufacturers and the guidance of users or prospective purchasers.

Gravity-type Drinking-bowls.—In this system the inflow of water to the drinking-bowls is controlled by a constant level water-tank, which is fitted with a ball-cock control (see Fig. 1). From this tank each individual bowl is supplied by a common pipe, the tank being situated so that the level of water in the bowls is at the desired height. In theory such a system has several advantages. It is simple in design, is subject to few possible mechanical faults, and is cheap to instal. Moreover, drinking-bowls of the gravity type can be made sufficiently deep to allow an animal to take long draughts of water without encumbrance.

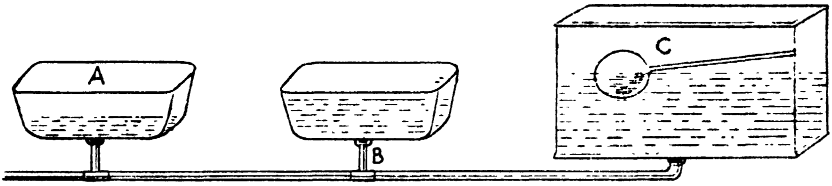

FIG. 1.—Illustrating the general construction of gravity-type water bowls. Drinking from bowl A causes lowering of water level. In re-filling, water flows from tank C, but also tends to pass the valve of feed pipe at B, thus drawing sediment into the feed pipe.

Gravity-type bowls possess, however, one great disadvantage when compared with pressure-type bowls. It is extremely difficult to keep the water in the bowls clean and wholesome, since morsels of food, such as fine meal unavoidably dropped into the bowls by the cattle, are liable to settle in the common feed-pipe, where they putrify and—in extreme instances—completely block the pipe. An attempt has been made to overcome this defect by inserting a valve in each incoming pipe at the point where it enters the bowl. By this means it was hoped not only to avoid contamination of the common feed-pipe with food particles, but also to prevent the back flow from one bowl to another, which normally occurs when the level of water in any bowl is lowered by drinking. Unfortunately, however, the difference in water-levels in a system of this type is so small (at the most 2 to 3 inches) that the valves fail to close effectively, and contamination of the feed-pipe with food particles is not prevented. It is, indeed, difficult to see how this fault could be remedied by any method which depends on water-pressure differences.

Pressure-type Drinking-bowls.—The principle adopted is to fit the inlet-pipe of each drinking-bowl with a spring valve which can be operated at will by the animal. Usually a hinged tongue is employed for this purpose. Depression of the tongue raises the valve and allows fresh-water to flow into the bowl, the flow ceasing as soon as the pressure on the tongue is released. In this system the water-supply may be taken direct from the main, provided the pressure on the pipes does not exceed 15 to 20 lb. per square inch. A higher pressure will result in "hammering" of the valve, which is governed by an extension coil-spring. Consequently where a high-pressure main supplies the byre, some method must be adopted to reduce the water-pressure. This is most easily effected by feeding the bowls from a large supply tank fixed about 15 feet above floor-level, this tank being in turn supplied with water from the main through a ball-cock tap.

It is very important that the inlet-pipe to each bowl should be of sufficiently wide bore to allow a generous flow of water : otherwise the animals will constantly be sucking air along with the water. It is recommended that pipes of at least $\frac{3}{4}$ inch diameter should be employed.

Shape of Bowl and Position of Tongue.—It is obvious that the shape of the bowl and the position of the tongue should be such as to allow the cow to drink in a natural manner. It is not generally realised that the cow, while drinking, is constantly moving her lower jaw. Any design which hinders this movement is unsatisfactory. The most common faults in the construction of pressure-type bowls are due to neglect of this principle. Fig. 2 shows, for instance, a typical bowl of faulty design. The bowl itself is circular and has deep sides, while the tongue lies across the bottom of the bowl. The deep circular shape does not allow the animal freedom for jaw movement, as this is restricted by the height of the rim. Such a bowl must be fixed at a low level if the animal is to be able to manipulate the hinged tongue, with the consequence that the bowl is too near the feeding-trough to be kept reasonably free from food contamination. Moreover, the situation of the tongue in the bottom of the bowl makes it difficult to operate, since the animal has to use her lower jaw to depress it. In attempting to drink, the animal allows the water to flow until it covers the tongue, after which she raises her head and sucks. The tongue, however, immediately rises into position and impedes drinking, with the result that the animal tends to suck in air instead of water. If observation is kept on animals using bowls of this type, the constant lowering and raising of the head provides a clear demonstration of the difficulty which is encountered in obtaining an adequate supply of water. Further, when the hinged tongue is fixed parallel to the bottom of the bowl, a "dead" space is formed beneath it in which meal and short straw—and even portions of roots—may lie. Unless the bowls are constantly cleaned, this will not only foul the water in the bowl, but will frequently impede the action of the hinged tongue.

In comparison with Fig. 2, Fig. 3 shows a bowl of ideal design. The bowl is elongated in shape, and the rim tapers forward, giving easy access and ample room for jaw movement. The hinged tongue is practically perpendicular and is placed well back, so that the animal can use her nose pad to operate the flow of water. By this means she can exert a constant forward pressure, thus receiving a continuous supply of water, while retaining perfect freedom of lower jaw movement for swallowing. Owing to its shape, a bowl of this design can be fixed at a much higher level than the bowl shown in Fig. 2, since the animal's head is not perpendicular when operating the tongue. The higher position of the bowl is advantageous as a safeguard against contamination with food debris.

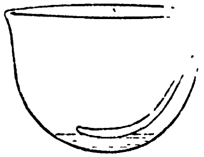

Fig. 2.—Faulty design, showing deep sides of bowl, and tongue parallel to base.

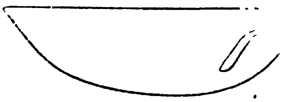

Fig. 3.—Correct design, showing shallow tapered bowl, and perpendicular tongue.

In the two types of pressure-bowl so far discussed the flow of water is controlled by hinged tongues. Other methods of control have been employed. For instance, the bowl itself has been used as a lever, the back of the bowl being hinged so that it operates the spring valve when the bowl is depressed. In considering the utility of such designs emphasis must be laid on the need for providing free lower jaw movement. Any bowl which interferes with such natural movement is unsatisfactory.

Access to Spring Valve.—It is important that the spring valve used to control the flow of water should be in an easily accessible position, and should be readily capable of adjustment. Occasionally a small particle of grit may get wedged between the valve surfaces, and so cause a continuous flow of water. Unless the valve construction is simple, considerable expense may be incurred in remedying such mechanical defects. With regard to accessibility for adjustment, a horizontal valve (Fig. 4 (*a*)) would be preferable to a vertical valve (Fig. 4 (*b*)). With the latter type it is frequently necessary to remove both the tongue and the bowl when adjustment is required, whereas with a horizontal valve this is unnecessary. On the other hand, the casting in which the spring valve is enclosed should be as small as possible (preferably with sloping sides) in order to prevent the collection of dirt and food debris above the bowl. The design of a horizontal valve which will meet this requirement is desirable, and would merit attention by manufacturers.

Position of Drinking-bowls.—The relation of the design of a bowl to the height at which it may be placed in the stall has already been discussed, and it has been pointed out that a good design allows the bowl to be fixed well above the feeding-trough, thereby reducing contamination with food particles. A further means of avoiding contamination of the bowls with fodder is to place each pair of bowls *between* animals in neighbouring stalls. When feeding, an animal collects a mouthful of meal, and then turns her head into the corner *away* from her neighbour. If, therefore, the bowls are fixed at the corners of the stalls, meal is dropped into them at every mouthful.

Some bowls are fitted with easily raised lids, with the object of reducing food contamination. It is possible that gross contamination might be reduced by this means, but in principle the simpler the working parts of a bowl are, the more satisfactory will it prove. A movable lid forms a lodgment for food particles, adds to cleaning, and may, in fact, merely form a trap for retaining dirt. On the other hand, a well-designed bowl, placed in the correct position and at the right height, can be kept scrupulously clean by wiping over once a day with a cloth, at little cost of time.

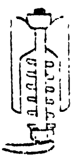

FIG. 4 (a).—Vertical valve, showing compact design but difficult access for adjustment.

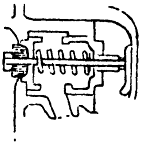

FIG. 4 (b).—Horizontal valve, showing easy access for adjustment, but difficulty in construction if compactness is to be secured.

Materials used in the Construction of Drinking-bowls.—It is essential that the materials used in the construction of drinking-bowls—and particularly that employed on the inner surface of the bowls—should be strong and durable, and should resist corrosion. A number of common materials have been tested, and the results may be summarised as follows :—

Galvanised Iron or Galvanised Pressed Steel.—It is well known that the galvanised surface of water-tanks occasionally corrodes under the action of water, but such corrosion is seldom serious. On the other hand, it has invariably been found that the galvanised surfaces of drinking-bowls corrode with extreme rapidity. If a shallow layer of water is left in such bowls, a deposit appears within a few days. When this deposit, which is found to consist of zinc oxide, is removed, a corroded or "pitted" surface is left. It was at first thought that this corrosion might be due to the nature of the local water-supply, which drains off peat moors and frequently has a definitely acid reaction. A sample of very hard water was therefore secured from a limestone area, and the bowls were tested with this water. " Pitting " again took place, though at a somewhat slower rate. The marked degree of corrosion which takes place in bowls covered only with a shallow layer of water appears to be a special instance of the well-known action of moist air in attacking the galvanised coating of metals. Such corrosion is not only detrimental to the life of the bowl, but may—if it occurs extensively —result in the ingestion of undesirable quantities of zinc salts.

Chromium-plated Cast Iron.—In an attempt to secure a more durable surface for the cast-iron bowls, tests were made on bowls which had been chromium plated. These again proved unsatisfactory. Shortly after the bowls had been installed for test, small pin-hole areas of rust formed on the plated surfaces. These areas spread, and ultimately resulted in the peeling of the chromium plating. An investigation of the cause of this condition was undertaken by Mr H. Cowan, of the British Cast Iron Research Association. The " pitting " was finally traced to the presence of small particles of graphite in the face of the casting. These particles failed to become plated with chromium, with the result that they were exposed to the action of the water, and ultimately allowed access of water to the under metal. An attempt is now being made to remedy this defect and to produce a chromium plating of guaranteed durability.

Aluminium and Aluminium Alloys.—A zinc-aluminium alloy proved useless, a white deposit of zinc oxide forming within a few days. On the other hand, pure virgin aluminium (99 per cent. pure metal) showed no corrosion after prolonged test. This metal was, however, found in practice to be too ductile, being easily damaged by the cattle.

Enamelled Surfaces. — A porcelain enamelled cast-iron bowl proved satisfactory in resisting water action, but serious trouble was experienced through the liability of the enamel to chip. This was particularly common in the moveable parts, especially at the hinges of the tongue, and also at the lip of the bowl. After a number of trials, however, a non-chipable enamel was finally procured, and this has so far proved ideal for both the stationary and working parts of the bowl.

Earthenware.—No opportunity has been available to test a bowl constructed of earthenware. At least one type of earthenware bowl is on the market, but it is usual to build this type of bowl into the wall. Unless this is done, there appears to be a distinct risk that the material may be fractured under hard usage.

Acknowledgments.—The author desires to acknowledge his indebtedness to the following firms for supplying drinking-bowls for trial :—

Messrs Thomas Cochran & Co., 69 Robertson Street, Glasgow, C.2 ; Messrs Cruikshank & Co., Ltd., Denny Iron Works, Denny ; Messrs George Paul & Co., Duncarron Iron Works, Denny ; Messrs A. & W. Pollock, Mauchline, Ayrshire ; Messrs Salopian Cattle Bowl Co., Prees, Whitchurch, Salop ; Messrs J. & R. Wallace, The Foundry, Castle Douglas, Kirkcudbright.

Special thanks are due to Mr Thomas Cochran, who kindly arranged for supplying the illustrations, and to Mr H. Cowan, of the British Cast Iron Research Association, Falkirk, for his co-operation.

WORM INFESTATION OF LAMBS

David Robertson, Ph.D., B.Sc.(Agr.), N.D.A.

Lecturer in Agricultural Zoology, North of Scotland College of Agriculture

Introduction.—One of the greatest handicaps to the business of sheep rearing is the incidence of disease. Even our most successful breeders and feeders experience losses from time to time, chiefly because more than half of all sheep losses seem to be traceable to parasites which are hidden from view. The very nature of the sheep's body, thin skin, warm coat, and lông food canal, proclaims it as an ideal home for parasites, and it is startling to realise that it is possible for no less than sixty different kinds of parasites to be present and gaining a living at the expense of the animal at one and the same time.

Without doubt the most important of these are the parasitic worms, namely, liverflukes, tapeworms and roundworms, of which twenty-one different kinds may be found invading the brain, lungs, liver, muscles, gullet, rumen, abomasum, small intestine and large intestine. We have little knowledge of the distribution and loss caused by these various worms throughout Scotland, but we do know that not a single sheep reaches the market free of parasitic worms, and that several farmers have been losing from 5 to 15 per cent. of their lambs as a result of this infestation. The total loss in the sheep industry in Scotland as a result of worm infestation is probably in the region of half a million pounds.

A survey of the different kinds of worms responsible for losses throughout the sheep districts of Scotland would serve a useful purpose, as it would enable the farmer to employ the correct methods of prevention and treatment which vary to some extent with the type of worm harboured. Such a survey was begun by the writer in the North of Scotland two years ago, and, although incomplete, some useful information has been gleaned from the three counties of Kincardine, Aberdeen and Moray. The investigations were largely confined to lambs showing symptoms of parasitic infestation, and the object of this paper is (1) to impress upon the farmer the fact that there is on his pastures a large and dangerous army of parasitic worms headed by the lesser stomach worm, ready to cause serious injury to his lambs as soon as opportunity arises; (2) to draw attention to the importance of the stomach worms, particularly the lesser stomach worm (*Ostertagia circumcinta*), of which a description of the symptoms of infestation, life-history and control is given.

The Numbers and Species of Worms found in Diseased Lambs.—Eight lambs showing symptoms of worm infestation or parasitic gastritis were examined, and in two cases the actual number of worms present was counted. A list is given below of the different species found in order of decreasing importance.

SHOWING THE DIFFERENT SPECIES OF WORMS IN ORDER OF IMPORTANCE FOUND IN THE FOOD CANAL AND LUNGS OF EIGHT LAMBS SUFFERING FROM PARASITIC GASTRITIS. LAMBS EXAMINED IN SEPTEMBER AND OCTOBER 1932.

Species of Worm	*Location*
FOOD CANAL	
Ostertagia circumcinta	Fourth stomach
Nematodirus filicollis	Small intestine
Cooperia curticei	Duodenum
Trichostrongylus vitrinus	,,
Hæmonchus contortus	Fourth stomach
Chabertia ovina	Large intestine
Trichuris ovis	,,
Moniezia sp.	Small intestine
Monodontus trigonocephalus	,,
Œsophagostomum venulosum	Large intestine
Capillaria longipes	Small intestine
LUNGS	
Muelleris capillaris	Long tissue
Dictyocaulus filaria	Bronchi.

SHOWING THE ACTUAL NUMBER AND SPECIES OF WORMS FOUND IN TWO LAMBS SUFFERING FROM PARASITIC GASTRITIS

Organ	*Species*	*Number* Morayshire Killed 26th Oct. 1932	 Kincardineshire Killed 16th Sept 1932
Fourth Stomach	Ostertagia circumcinta	16,930	18,110
	Hæmonchus contortus	53	76
Small Intestine	Nematodirus filicollis	1,238	1,981
	Trichostrongylus vitrinus	256	161
	Cooperia curticei	98	354
	Monodontus trigonocephalus	7	2
Large Intestine	Chabertia ovina	19	26
	Œsophagostomum venulosum	8	..
Caecum	Trichuris ovis	8	12

A glance at the above table shows the remarkable extent to which a lamb may become infested with worms. Such a state of affairs invariably arises on farms where the ewes and lambs have been grazed throughout the summer months on foul or "sheep-sick" pasture.

The Kincardineshire farm from which the lamb yielding 18,110 lesser stomach worms was taken, gives an interesting insight into the main predisposing cause for worm-infested sheep, viz.—overcrowding. Extending to 325 acres, 100 acres of which were pasture, this farm usually carried from 400 to 500 hoggs bought in during August and fattened off in spring. Under this system worm infestation was unknown. When the decline in arable farming came, the farmer decided to put more of his fields down to permanent pasture, and in 1928 he procured 100 Greyface breeding ewes. In 1929, 300 more Greyface ewes were bought, which meant that in the summer of that year the 260 acres of pasture he had available for grazing were carrying approximately 375 ewes and their 500 lambs, a total of 875 sheep. This stocking was maintained in 1930, 1931 and 1932. But in 1931 trouble arose. Towards September the lambs began to fall off in condition, and fresh pasture had to be rented elsewhere to get them in a fit condition for the market.

In 1932 serious loss was experienced, about 10 per cent. of the lambs having died, and it was then that advice was sought as to the cause of the trouble. Examination of diseased lambs proved that the cause of death was due to parasitic gastritis, the lesser stomach worm being the principal offender. Thus in the short space of four years this farm had become useless for sheep rearing on account of the pasture having become heavily infested with worms. It is an excellent demonstration of the danger of sheep farming on a large scale with only a limited grazing area available. Probably hundreds of similar examples could be found throughout the country where the arable farmer was more or less forced to take up sheep rearing in view of the poor returns from other branches of farming.

The Importance of the Lesser Stomach Worm (*Ostertagia circumcinta*)—The fact that in untreated sheep the lesser stomach worm is always found in much larger numbers than any of the other species is interesting, and the probable explanation would seem to be that the climatic conditions in Scotland are more favourable to this parasite. Occurring in enormous numbers in the fourth stomach or abomasum it is undoubtedly the most serious parasite in the digestive tract, and mainly responsible for the disease known as parasitic gastritis.

Nematodirus, a slender worm about 1 inch in length is the next parasite of importance. It occurs in the small intestine often in large numbers, in which case it may play a considerable part in bringing about disease symptoms.

Trichostrongylus and *Cooperia*, two very slender worms about

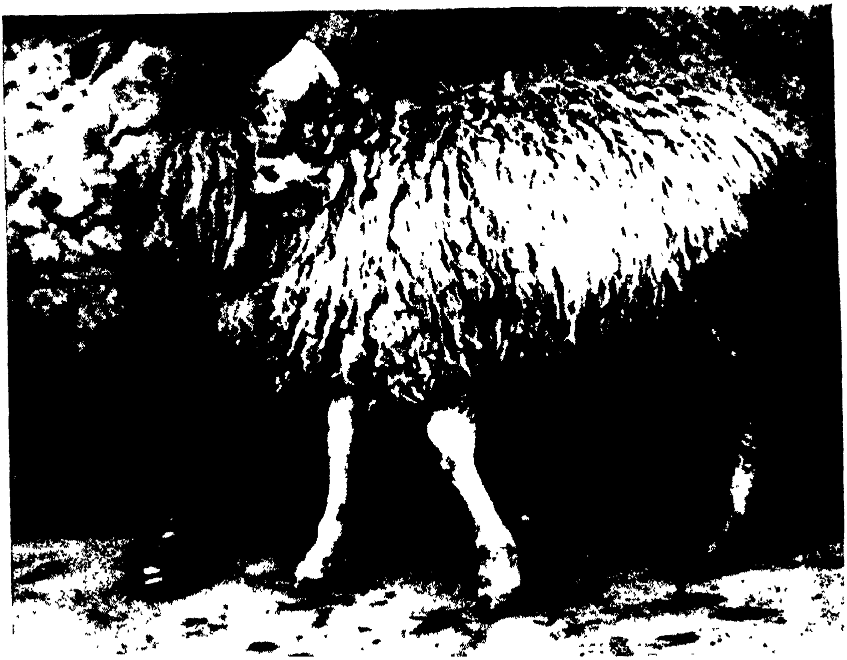

FIG. 1.—A nine-months-old Hogg suffering from parasitic gastritis caused by the lesser stomach worm. The typical symptoms of worm infestation—stunted growth, harsh dry coat, dull eye and soiled hindquarters—are evident in the photograph.

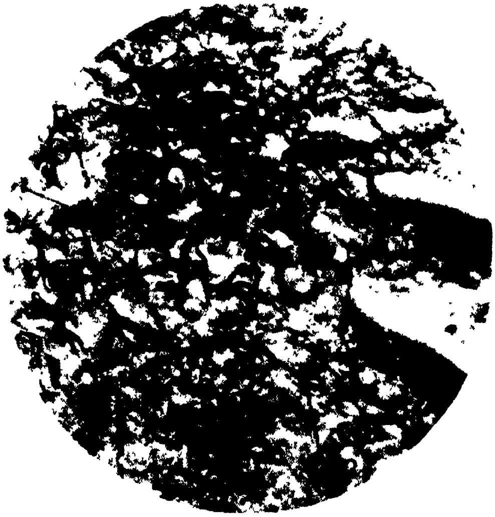

FIG. 2.—The Lesser Stomach Worm (*Ostertagia circumcincta*) adhering to the lining of the abomasum. (Twice natural size.)

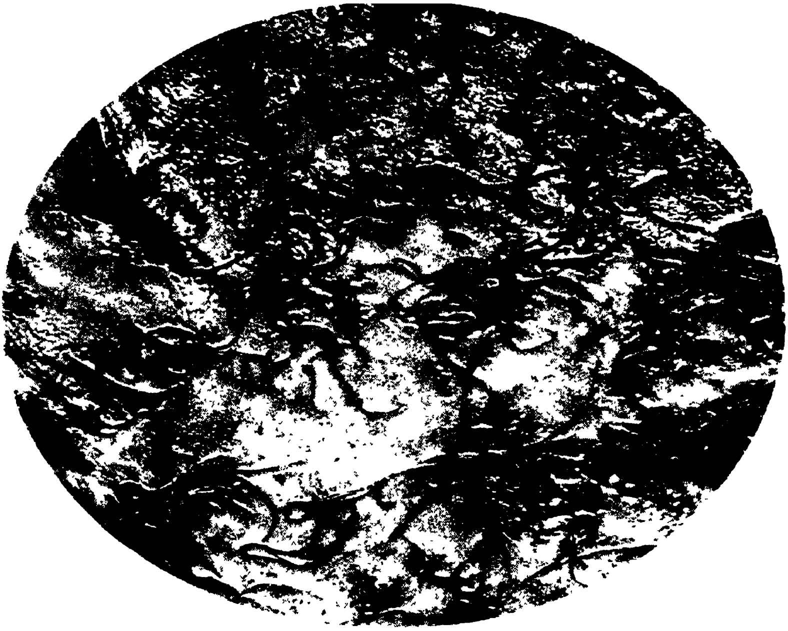

FIG. 3.—The Twisted Wireworm (*Hæmonchus contortus*). The twisted nature of the egg tubes, which make from 12 to 14 turns round the intestine, is clearly shown. (Natural size.)

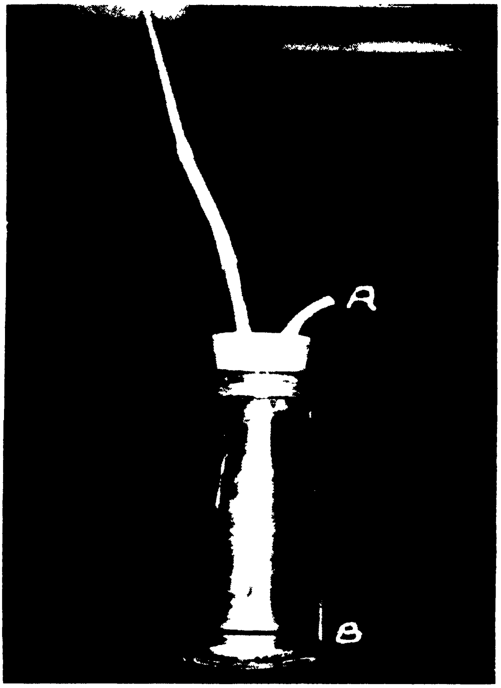

FIG. 4.—An inexpensive bottle suitable for dosing sheep. A piece of black paper (B) gummed on to the side of the bottle indicates the correct dose of a one per cent. solution of copper sulphate (*i.e.* one fluid ounce) for a lamb three months old. By placing the thumb over the small tube (A) the dose can be prevented from flowing too quickly into the mouth of the animal.

¾ inch in length, and difficult to detect, are found in the duodenum, the first part of the small intestine. Belonging to the same group as *Ostertagia*, they cause the same type of injury, and probably play a considerable part in bringing about parasitic disease. No efficacious treatment has as yet been discovered for their removal.

Hæmonchus contortus, commonly called the twisted wireworm, is one of the best-known roundworms in the sheep. It is over 1 inch in length, and is easily recognised by its reddish colour, due to ingested blood. Although extremely common and pathogenic in some parts of the world, it appears to be of minor importance in this area.

Chabertia, *Trichuris* and *Œsophagostomum* in the large intestine, *Monodontus* and *Capillaria* in the small intestine seldom occur in sufficient numbers in lambs to do damage. In older sheep, however, *Monodontus*, commonly called the sheep hookworm, is a common parasite.

Only in two of the eight lambs examined were tapeworms (*Moniezia expansa*) found.

Lambs infested with intestinal worms usually harbour a number of lungworms, of which *Muelleris capillaris* or tissue lungworm is the most common. It gives rise to nodules in the lung tissue (commonly known as pseudo-tuberculosis), and unless very numerous does not seem to cause much discomfort. *Dictyocaulis* is a much larger worm than *Muelleris*, the female being about 2 to 4 inches long. It inhabits the bronchi and bronchioles giving rise to a condition known as Husk. The largest number found in any one lamb was eight.

The Lesser Stomach Worm (*Ostertagia circumcinta*).—Probably the reason for this parasite being little known compared with the twisted wireworm, *Hæmonchus contortus*, is that, in view of its smaller size, it is often unnoticed at post-mortem examination. Being only ¼ to ½ inch in length and about $\frac{1}{250}$ inch in thickness it is almost impossible to detect, unless the stomach contents are submitted to a simple process of sedimentation beforehand. The method requires no expensive apparatus, and can be carried out in the field. The fourth stomach contents are poured into a bucket or a large glass jar, and water added until the bucket is full. After being allowed to settle for 15 to 20 minutes the supernatant fluid is poured off and the bucket refilled with water. This process is repeated three or four times. The worms plus sediment will now be found at the bottom of the bucket in clear water. A portion of the sediment is then poured into a flat-bottomed dish, preferably a black photographic dish, along with a small quantity of water. The worms will now be plainly visible to the naked eye.

Since parasitic disease depends largely on the number of parasites, it is important to gain some idea of the approximate number of worms present. Every lamb from the time it begins to eat grass will harbour stomach worms, and it is only after the numbers have accumulated and reached a certain limit that symptoms of worm infestation are likely to appear. As a result of actual counts which have been made for diseased and normal lambs, it would appear that symptoms of lesser stomach worm disease are unlikely to appear unless the numbers reach beyond 8000. From 15,000 to 20,000 have been found to give typical symptoms of worm infestation and to cause death. Normal lambs have yielded from 2000 to 5000 lesser stomach worms without clinical signs of infestation. Nutrition, of course, plays an important part in the question of numbers and resistance to disease, a well-fed lamb being better able to resist a larger number of parasites than one poorly fed. It follows, therefore, that the mere finding of worms in an ill-thriving sheep is not sufficient evidence that its poor condition is due to parasitic infestation, unless other factors, such as (1) visible signs of worm infestation, (2) numbers of worms, (3) management and feeding of the sheep, have been taken into account.

Symptoms of Stomach Worm Disease.—September and October are the months in which symptoms of worm infestation in lambs appear in Scotland. In general, the symptoms of lesser stomach worm infestation are similar to those produced by the other worms found in the alimentary canal. At first there is a progressive loss of condition, the animal assuming an ill-thriving and stunted appearance. The wool becomes dry, the eye dull, and if the inner membrane of the eyelid be examined closely, it is found to be markedly pale in colour. There is a discharge from the eye which causes the hair round the lower eyelid and part of the cheek to become matted. Scouring takes place intermittently, the hindquarters of worm-infested sheep invariably being soiled with liquid excrement. If a lamb showing these symptoms is not put on to clean pastures at once, it will gradually become weaker and finally die from exhaustion.

The Life-cycle of the Lesser Stomach Worm.—The life-cycle of the lesser stomach worm has not yet been worked out in full, but it is generally thought to be similar to that of the twisted wireworm which has been studied in great detail by Veglia (1).

The adult females in their position in the fourth stomach give rise to thousands of eggs which find their way to the exterior in the droppings. In from one to two days these hatch into small active first-stage larvæ which feed on the disintegrating fæces. These first-stage larvæ must now pass the next two stages of their growth on the ground before they are capable of infecting the sheep. They grow and moult their skins twice to become fully grown in a length of time depending on the conditions of temperature and moisture. In this country Taylor (2) states that it can only be in our warmest weather that they reach the infective stage in less than ten days.

The skin cast by the second-stage larvæ is retained by the infective stage as a loose protecting sheath, which enables it to resist adverse climatic conditions such as cold and dryness, and to remain alive in the absence of the sheep, for a long period, probably about twelve months. This is a most unfortunate feature of the development of the worm, as it means that a period of about one year must be allowed to lapse before an infective pasture can be expected to be safe for grazing again.

The infective larvæ do not remain at rest in the soil. Provided sufficient moisture is present to facilitate movement they climb on to the grass blades to be swallowed by the sheep. When this happens further development takes place in the fourth stomach, males and females being formed.

Prevention.—The aim of every sheep farmer should be to manage and graze his flock in such a way that heavy infestation cannot take place. Although it is impossible to rear lambs entirely free of worms, under the usual grazing system, a great deal can be done to lower the risk of infection by arranging a suitable grazing programme.

The ewes, which are never free of worms, are the main source of infection for young lambs. The infective larvæ which they pick up immediately they begin to eat grass mature and give rise to more eggs in a period of 30 days. The fecundity of a stomach worm is amazing. Stoll (3) found that 2 lambs grazing in a series of four plots, one of which received 45 infective *Hæmonchus* larvæ, expelled in the course of 119 days a total of 456,600,000 eggs. This means that eggs were being passed out on to the grass on which the sheep were feeding at the rate of 44 per second. Probably a higher figure would be found in the case of the lesser stomach worm. Such a high rate of reproduction must necessarily lead to a heavy infestation of the pasture in a short time, and unless the ewes and lambs are shifted frequently on to clean ground a high degree of infestation will arise.

In the paragraph dealing with the life-cycle, it will be noted that the larvæ on hatching from the egg require a period of approximately 10 days to become infective. Should ingestion take place before this infective stage is reached the parasite is destroyed in the digestive tract. Theoretically, therefore, if in-lamb ewes are put to graze on pasture which has never carried sheep and the field grazed in sections, with 10-day intervals to each shift, the lambs should be worm free at the end of September. An experiment to find out to what extent stomach worms could be controlled by this system of rotational grazing was carried out at Craibstone in 1932, the sheep and management being provided by the Rowett Institute.

A three-acre field of excellent third year's grass which had never carried sheep was fenced into two equal portions. Six Blackface ewes and their twin Greyface lambs, approximately six weeks old, were put into one-half of the field on 25th May, and allowed to graze over the whole 1½ acres up to 28th August 1932. An equal number of ewes and lambs were allowed to graze only $\frac{1}{10}$th of the other half at one time, the ewes and their lambs being changed to clean sections at 10-day intervals.

On 28th August all the lambs were slaughtered and the worms in the fourth stomach counted. The result showed a reduction of 99·2 per cent. for *Hæmonchus* and 80·8 per cent. for *Ostertagia* compared with the control group.

In practice it is seldom possible to introduce such an intensive system of rotational grazing. But there is little doubt that the solution to the problem of prevention of stomach worms is that of shifting the lambs on to clean grass as often as possible during the months most suitable for quick development of the larvæ, namely, July and August. To crowd a flock of ewes and lambs during the summer on to a field which has been previously heavily grazed with sheep is bound to lead to trouble, as the lambs are being given every chance of reinfection.

In planning the grazing programme the first year's grass should be reserved for the ewes and their lambs. Not only is it infinitely higher in feeding value than old grass, but it will be free of worms, provided sheep have been kept off it during winter. Ewes are never free of worms, and are the first to sow grass with eggs; for this reason, and many others, young grass should not be grazed during the winter months.

Grazing cattle and horses along with sheep is strongly advised, Most of the parasitic worms of the sheep are unable to reproduce, or are destroyed in the digestive tract of those animals, and consequently they will help to reduce the number of infective larvæ.

Pastures which have become so heavily worm-infested as to give severe cases of parasitic gastritis should be ploughed up. The alternative is to keep sheep off for a year.

Treatment—Although many experiments have been carried out against the lesser stomach worm with all the well-known anthelmintics, none has given much satisfaction. It would appear that the small size of the worm enables it to receive a considerable degree of protection from the lining of the stomach.

The most helpful drug is carbon tetrachloride in from 2 to 5 c.c. doses. Experience shows that there is some risk in administering carbon tetrachloride if the sheep have been receiving concentrates, or have been given a change of food after dosing. It is urged, therefore, that lambs receiving concentrated food should not be dosed until such food has been withheld for 10 days. After dosing they should be returned to the grass and no concentrates given for a week.

For sheep infested with the twisted wireworm a 1 per cent. solution of copper sulphate is the most effective remedy. It will also expel tapeworms and a considerable number of the other worms inhabiting the intestines. A 1 per cent. solution is made by dissolving ¼ lb. of copper sulphate crystals in 2½ gallons of water in a wooden or enamelled vessel. The exact dose depends on the age of the animal, and should be given as follows :—

Adult sheep	3½	fluid	ounces.
Year-old sheep . . .	2½	,,	,,
Six months' lambs . . .	1½	,,	,,
Three months' lambs . .	1	,,	,,

Since this drug will have more effect when the stomach is empty, the animals should be starved for 12 hours before treatment and 6 hours after treatment. The dose is best administered by means of a special drenching bottle. For this purpose the writer has found an ordinary ½-pint milk bottle with a two-holed rubber stopper highly successful (Fig. 4) An 8″ piece of ¼″ inch bore copper tubing is fitted into one hole and a 3″ piece into the other. The smaller piece of copper tubing (A) is adjusted so that one can place the thumb over it and prevent the dose from flowing too quickly into the mouth of the animal. If the sheep are still being grazed on infested pasture the dose should be repeated once a month throughout the summer.

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PEAT MOSSES—III

COMPOSITION OF PEAT AND THE LIMING AND MANURING OF PEAT SOILS

IAN M. ROBERTSON, B.Sc., Ph.D.
Macaulay Institute for Soil Research

Chemical Composition.—It has been pointed out[1] that the formation of peat is due to the gradual accumulation of plant remains, and it follows therefore that peat is mainly organic in origin. Varying, though usually small, amounts of mineral matter are derived from the plants which form the peat and also from the animal life associated with them. Mineral matter, apart from that of organic origin, is either blown from the surrounding country on to the peat land, or carried there by water, in solution or in suspension.

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[1] Peat Mosses, I, *Scottish Journal of Agriculture*, 1933, xvi., 50-58.

Organic Constituents.—The changes accompanying the conversion of plant debris into peat are still very imperfectly understood, but it is evident from analyses of peat, and of the plants which form it, that the " humification " processes represent a most complicated series of chemical reactions. However, since it is not yet known whether organic substances are absorbed by plants and utilised by them as nutrient, it is of no immediate importance to give a detailed description of the organic products of peat, especially in a paper dealing with the development of peat areas as agricultural land. At the same time several important properties of the organic colloids of peat must not be lost sight of, and much of the success of modern moorland farming has followed directly from detailed studies of these.

One of the most striking changes taking place during the humification of plant remains is the formation of an organic compound called " humic acid," which produces an acid reaction in the soil unless sufficient base is present to neutralise it. It fenland there is usually an abundance of lime in one form or other which combines with the acid, giving a neutral or slightly acid soil, but in most of our peat mosses the supply of lime is extremely small so that an intensely acid condition is set up. Extreme soil acidity is, of course, detrimental to the growth of most plants and bacteria, and a study of humic acid and its properties has led to a better understanding of the problems of peat land reclamation.

Humic acid, or more correctly humic acids (for there is more than one acid formed during humification), are brown colloidal substances of unknown constitution having all the properties of colloids and of true acids. Their harmful effect on plant life is twofold, and is brought about by the direct action of the acids in the one case, and by the decomposition of mineral salts (*e.g.* manure salts) to free acid in the other. If, for example, a neutral salt such as potassium sulphate is added to an acid peat soil, the humic acid combines with the potassium forming potassium humate, and sets free sulphuric acid which is harmful to plant and animal life. Since humic acid is only slightly soluble in water the decomposition of neutral salts is not very apparent so long as only small amounts of the salts are used, and this explains why, in the early days of peat land cultivation, good crops were obtained with dung alone. As soon as large amounts of artificial manures are added, however, the formation of free acid from the neutral salts becomes so great that harmful effects are experienced immediately.

It has been mentioned that the humic acids are colloidal in character, and in virtue of this exert forces which hold other substances firmly attached to their surface. Thus, for example, the greater part of the naturally occurring phosphoric acid in acid peat mosses is bound up at the surface of the colloidal particles, and is quite unavailable as plant nutrient until the forces exerted by the colloids are broken down. Drying in the air, or heating, or the addition of certain chemical reagents brings about this change, and much of the success of the old method of paring and burning peat land before cultivation was due to the action of the heat in rendering available the phosphoric acid held at the surface of the humic matter.

The organic combustible material in peat consists for the most part of compounds of carbon, hydrogen, oxygen and nitrogen, with small amounts of several other elements. The following figures give average values for the composition of the organic matter—carbon, 56 per cent.; hydrogen, 5·5 per cent.; oxygen, 34 per cent.; nitrogen, 1·0 to 3·7 per cent. It is not yet known with certainty in which form the nitrogen exists in raw peat, but it originates from plant and, to a small extent, animal proteins. These substances resist decomposition to a marked degree, and it follows that although peat contains a large percentage of total nitrogen (about ten times that of a mineral soil) only a small amount of this is available until chemical and biological processes are set up to bring about the decomposition of the protein residues. Ammonia is absent, or at least exists only in minute quantities.

Inorganic Constituents.—The inorganic substances occurring in peat which are of most importance from the agricultural point of view, are lime, phosphoric acid, and potash. On account of the very different conditions under which peat may accumulate, it is only natural to find a wide range in the chemical composition. For example, fen peat may have a high percentage of mineral matter because it is formed in areas where the groundwater has an abundant supply of plant nutrients. Moss peat on the other hand contains an extremely small amount of mineral matter, and without treatment is a most unproductive soil. A few examples of the chemical, together with the botanical composition of a few typical peats, will serve to illustrate the variability which exists—

1. Scirpus Peat composed mainly of Scirpus (Deer's Hair grass), with a small amount of heather, mosses, and cotton grass.

2. Eriophorum Peat, almost entirely composed of Eriophorum (Cotton grass).

3. Sphagnum Peat, from a number of Sphagnum species with isolated remains of cotton grass and heather. Undecomposed upper layer.

4. Sphagnum Peat. Well decomposed lower layer.

5. Heather Peat, formed almost entirely of Calluna (Heather).

6. Alderwood Peat, composed of broken twigs, leaves, etc. of Alder.

7. Sedge Peat, remains of Carex species (Sedge).

8. Phragmites Peat, remains of Phragmites (Reed).

The first five examples are typical of peat mosses, the remaining three belong to the fen types. The Alderwood Peat is strictly speaking a Carr Peat.[1]

Percentage Chemical Composition of Typical Peats

Example No.	1	2	3	4	5	6	7	8
Nitrogen (N)	1·5	0·8	0·7	1·2	1·5	2·0	2·6	2·5
Lime (CaO)	0·4	0·1	0·2	0·3	0·2	1·8	2·5	2·0
Potash (K_2O)	0·1	0·04	0·05	0·03	0·07	0·07	0·08	0·1
Phosphate (P_2O_5)	0·1	0·02	0·04	0·03	0·1	0·1	0·2	0·2

The Scirpus peat is from an area where the moisture conditions are excessive, and where water flowing from the surrounding soil, carrying mineral matter in solution or suspension, runs over the surface of the peat moss. This may account for the slightly higher values than in the other moss types.

The reason for the great natural fertility of fen peat as compared with our Scottish Sphagnum and Scirpus peats will be seen at a glance. The latter have a very poor supply of nutrients, and although the nitrogen values are high, the amount available to the plant is very small indeed. In fen peat, on the other hand, because of the presence of lime (and hence the absence of acidity) bacterial and chemical action is stimulated and the nitrogen rendered available as nutrient.

The naturally-occurring lime is usually combined with humic acid in the form of calcium humate. This substance is unstable, and is readily oxidised to a decomposition product of humic acid and calcium carbonate, which in turn forms more calcium humate by combining with fresh humic acid, and so on, in a continuous cycle. This explains why peat soils having sufficient lime either through natural or artificial agencies, decompose more readily and form a soil more quickly than those where lime is absent.

The phosphoric acid is combined in peat in an organic form and held at the surface of the humus colloids. In very rich peats having a large content of phosphoric acid, iron phosphate (vivianite) is found in bog iron ore. Peat is very retentive of phosphoric acid, and even after dressings of phosphatic manures have been applied, only very minute losses due to leaching are observed.

The potash content of peat is as a rule very small, and in comparison with phosphoric acid is much less firmly held, being almost completely soluble in water. Since as much as 50 per cent. of the total potash present may be removed by the crop, fairly good yields, showing little or no potash starvation, may be obtained in the first year, even with the comparatively small amounts of potash occurring naturally. This apparent sufficiency of potash is often misleading, and unless potassic fertilisers are applied, a marked deficiency becoming increasingly obvious as time goes on will be observed. It is therefore customary to manure fairly heavily with potash in the first year or two in order to build up a reserve. In this connection it is interesting to note that numerous analyses of drainage-water have shown that, in spite of its great solubility, only small amounts of the potash added is washed out.

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[1] Peat Mosses, I, *Scottish Journal of Agricultural*, 1933, xvi., 50-58.

Biological Properties.—Under the natural conditions of high acidity usually prevailing in peat land, bacterial activity is reduced to a minimum, indeed many of the commoner soil-forming bacteria are entirely absent. Numerous investigations have shown that all peat soils contain bacteria which bring about the decomposition of protein and the formation of ammonia. This is especially the case with the surface samples which in most cases contain considerably greater numbers of bacteria than the lower layers. After cultivation, liming, and manuring processes have been carried out the formation of ammonia is increased to a very large extent, and particularly so following the application of dung. The increased bacterial activity is confined to the upper layers, and the material below the depth of cultivation (about 9 inches) shows very little difference from that of the uncultivated land.

Nitrifying bacteria are absent both in the surface and lower layers, but appear in the former in a cultivated soil as soon as moderate dressings of lime (¾ to 1 ton per acre) are added. Optimum conditions are not attained, however, until sufficient lime has been given to neutralise completely the natural acidity of the peat. Such conditions, as will be seen later, are highly undesirable.

All acid peat soils contain, in both upper and lower layers, denitrifying bacteria which bring about decomposition of nitrates and nitrites. After liming and cultivation the numbers of these bacteria increase enormously, and it is therefore important that heavy applications of lime should be avoided, otherwise harmful effects will be experienced from the changes brought about by the bacteria. It has been shown, however, that after moderate dressings of lime (insufficient to produce optimum conditions for nitrifying or denitrifying bacteria) good crops of oats, rye and potatoes can be grown with the addition of ammonium salts, and this fact is taken as a proof that our agricultural plants can absorb their nitrogen in the form of ammonia.

The nodule bacteria which enable legumes to utilise atmospheric nitrogen are, as a general rule, absent in uncultivated acid peat, but in some areas where sheep have been grazed they are found in large numbers. It is generally advisable, however, to have clover seeds inoculated before sowing.

Liming.—As already outlined the presence of the correct amount of lime is an important factor in moorland cultivation. Under natural conditions such a state of affairs is rarely met with, and only in some of the fen peats does a sufficiency of lime occur. As can be seen from the table already given, the peat mosses are very poor in lime, and heavy dressings have to be given before successful cultivation work can be carried out. At the same time care must be taken to avoid overliming. Experience has shown that on acid peat the optimum conditions are obtained by the addition of lime at the rate of 20 to 25 cwt. per acre (or 40 to 50 cwt. carbonate of lime) for cropped land, and 35 to 40 cwt. per acre (70 to 80 cwt. carbonate of lime) for grass land. The latter requires more lime than cropped land because of the high percentage of lime-loving clover plants it contains. It is interesting to note that while grasses sown alone are very susceptible to overliming, and grow best under conditions similar to those for cropped land, they thrive exceedingly well when mixed with clovers in soils receiving the heavier dressings of lime.

The action of lime remains effective for many years, especially if phosphatic manures rich in lime (basic slag, ground mineral phosphate, etc.) are used. It has been shown, for example, that the normal additions of phosphate in the form of basic slag introduce at the same time sufficient lime to replace what is removed in crop and drainage.

Lime may be applied as oxide (ground lime), hydrate (slaked lime), or carbonate (ground limestone, waste lime, marl, shell sand, etc.). It is important that the material should be dry, and in the finest possible state of subdivision, so that it may be spread over and worked in uniformly throughout the area. These points cannot be too strongly emphasised, as much of the success attending the cultivation of acid peat land is determined by the amount of lime added, its fineness of grinding, and the uniformity of its distribution. It will be appreciated that an even sowing of finely-ground lime from a distributor will have a much more complete and rapid neutralising effect on the peat than the irregular scattering of lime, or the sowing of a lumpy or coarsely-ground product. If the area is to be ploughed, about a third or a half of the lime should be spread on the surface, and worked in with disc harrows before ploughing. The remainder of the lime is applied after ploughing and worked in as before with the disc harrow. In this way a good intermixing of soil and lime to the depth of cultivation is obtained. It is often the custom to crop a reclaimed soil for a year or two before laying it down in grass, and in such cases it is advisable to add only 20 to 25 cwt. of lime per acre so long as the land is in crop. Shortly before the grass seeds are sown, lime should be added to bring the total application up to that required for grass land.

Artificial Manuring.—Except in a few isolated cases the amounts of naturally occurring phosphate, potash and available nitrogen in peat mosses are very low, and quite inadequate for normal crop production. Accordingly, heavy dressings of artificial manures should be given in the first two or three years in order to build up a reserve. Suitable dressings of potash and phosphate for this period are 120 to 150 lb. per acre phosphoric acid (P_2O_5) as basic slag (7 to 9 cwt.). or ground mineral phosphate (3 to 4 cwt.) and 150 to 170 lb. per acre potash (K_2O) as potash manure salts (4½ to 5 cwt.). Under normal conditions of liming for acid peat mosses the phosphate is best given in the form of basic slag or ground mineral phosphate. The latter is a most suitable source of phosphoric acid, as it has been shown to give a good supply of "available" phosphate in presence of the humic acid of acid peat. It has the additional advantages of low cost per unit, high percentage of phosphoric acid, and hence low transport outlay. It should be ground finely and evenly distributed over the area.

The continuous use of superphosphate is not to be encouraged since it contains appreciable amounts of calcium sulphate. This substance is decomposed by humic acid to free sulphuric acid, a reaction which is immediately harmful to plant life. On fen peats rich in lime, or where an excess of lime has been added, there is insufficient humic acid to render available the phosphate of ground mineral phosphate so that some other source must be obtained. In such cases there is no decomposition of calcium sulphate, and superphosphate can be used with safety. Phosphatic manures should be applied in autumn or early spring in order that sufficient time may elapse to allow the solvent action of the humic acid to come into play.

The potash of moorland soils is much less firmly held than the phosphate, and this is especially the case after a reserve has been formed. It is therefore advisable to apply potash every year in the quantities and form most suitable for the crop to be grown. Kainit and potash manure salts are very suitable sources of potash, but the former is somewhat costly in this country, and, on account of its bulk, has a much higher freightage than the latter. High-grade potash manure salts possess the additonal advantage of low chloride content, and this is particularly important where crops which react unfavourably to chlorides (*e.g.* potatoes) are to be grown. On the Continent it is customary to use sulphate of potash and sulphate of potash and magnesia for potatoes. On grass land, however, high-grade potash manure salts give the best results, and are to be recommended in all cases where heavy dressings of potash are to be given. With regard to the time of application of potash to freshly reclaimed moorland, it is advisable to give the first dressing in autumn or early spring so that a good admixture with the upper layers of the soil is obtained. The risk of loss through leaching is minimised if small dressings are given. In later years the potassic fertiliser should be given in the late spring.

It has been observed that the harmful effects of late frosts, which are so prevalent in peat soils, are absent, or at any rate lessened, on land treated with potash, but as yet no satisfactory reason has been put forward to account for this.

After the heavy dressings of phosphoric acid and potash given in the first two or three years the amount of manure to be added in succeeding years is determined by the crops removed, and the type of crop to be grown. In the case of potash the loss due to leaching (usually comparatively small) must also be taken into account. The following dressings have been found satisfactory:—

for cropped land:
80 to 90 lb. per acre potash (K_2O),
50 to 60 lb. per acre phosphoric acid (P_2O_5);

for every ton of air-dried hay:
45 lb. per acre potash,
15 lb. per acre phosphoric acid;

and for permanent pasture:
60 lb. per acre potash,
30 lb. per acre phosphoric acid.

Nitrogenous Manures.—In freshly reclaimed peat land (except with fen peat) it is some time before the effects of drainage, cultivation, liming and bacterial action render available sufficient nitrogen to dispense with the use of artificial nitrogenous fertilisers. In the case of legumes, where sufficient nodule bacteria are present, it has been found possible to grow good crops without the use of artificial nitrogen. In fact, there are indications that the grasses of a grass-clover crop obtain some benefit from the nitrogen fixed by the legumes. All other crops, however, require reasonably heavy dressings, and it has been found that about 40 to 50 lb. per acre nitrogen is suitable for cereals, while roots should receive slightly more than this. In older cultivations where use has been made of farmyard manure, and where the drainage and liming conditions are satisfactory, the application of nitrogenous fertilisers may be reduced, or even omitted, as sufficient of the naturally occurring nitrogen will have been rendered available.

The form in which the nitrogen is to be applied has next to be considered. Physiologically acid manures, such as sulphate of ammonia, should be used only in soils having a sufficient reserve of lime to neutralise the acidity formed during the absorption of the manure by the crop. (A manure is said to be physiologically acid when one part—the basic ion—is removed by the plant, and the other—the acid ion—remains in the soil. For example, the ammonium ion of sulphate of ammonia is absorbed by the plant, while the sulphate ion remains behind giving the soil an acid reaction). Where insufficient lime is present, physiologically alkaline manures, such as saltpetre or nitro-chalk, should be used. The least suitable nitrogenous fertiliser for peat land, and especially for freshly reclaimed areas, is calcium cyanamide, and should it be decided to employ this substance, care should be taken to apply it early in the season, and have it properly worked in to the depth of cultivation sometime before sowing the crop. The application of nitrogen should be made at the time of sowing, except with crops like potatoes, which develop slowly, when it may be given a week or two after planting. With grass land it is not advisable to dress with nitrogen, except perhaps in small quantities with the seeds.

Farmyard Manure.—The high value of farmyard manure in the cultivation of peat land was recognised by the early workers,[1] and many good crops were grown with dung alone. Modern research has shown that the success attending the use of dung is twofold, and depends on its content of plant foods, and on the large numbers of bacteria which it introduces into the almost sterile peat soil. As has been pointed out the conditions most favourable for the development of these bacteria are not generally found in peat land until the naturally high acidity is reduced to some extent by the addition of lime. The most successful results therefore follow a combination of the processes of liming and manuring. The application of dung is especially important in freshly reclaimed peat land which has a very low bacterial population. Grass land as well as cropped land responds to a dressing of dung in early spring, and for this purpose well-decomposed manure should be used.

The action of the various composts is similar to that of farmyard manure, the aim being to introduce bacteria and to some extent plant foods into the soil.

In conclusion, mention must be made of green manuring, which forms an extremely valuable source of nitrogen in peat soils. The practice consists of sowing a leguminous crop inoculated with nodule bacteria and ploughing it down when growth ceases. In this way the atmospheric nitrogen stored up by the legume is returned to the soil in an available form.

The Uses of Oats and Oat Products in Pig Feeding

THIS article is contributed by A. H. Blissett, B.Sc., Duthie Experimental Stock Farm, Rowett Research Institute.

In view of the present low price of oats the value of this food for feeding to live stock is worthy of considerable attention. It has been stated that oats contain much husk, and for that reason are not suitable for pig feeding (1). This may be the view of most pig-feeders, and some recent experiments on oats and oat products conducted at the Duthie Experimental Stock Farm, Rowett Institute, are therefore of special interest.

In an experiment designed for other purposes than testing the feeding value of oats, it was necessary to feed to young pigs a ration which contained 70 per cent. of crushed oats. This ration was tested against a standard one which was apparently superior to it in every way. The results, however, were interesting, and demonstrated that crushed oats fed in a dry state may form up to 70 per cent. of the total ration for pigs over 100 lb. live weight.

There were four groups of 10 pigs each, and two of these group were fed on a standard basal ration, and the other two groups on a ration of 70 per cent. crushed oats, 23 per cent. barley meal and 7 per cent. meat and bone meal plus 2 lb. separated milk per pig per day. In the following table of results the groups marked A are comparable and the other groups marked B are also comparable :—

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[1] Peat Mosses, I, *Scottish Journal of Agriculture*, 1933, xvi., p. 55.

TABLE I

	Standard Ration		Crushed Oats Ration	
	A	B	A	B
Av. initial wt., 2/12/30 (lb.)	36·7	36·6	36·6	36·7
Av. wt., 10/3/31 (lb.)	109·3	107·1	94·6	97·7
Gain in 70 days (lb.)	72·6	70·5	58·0	61·0
Av. final wt., 11/4/31 (lb.)	146·9	144·5	134·9	141·1
Gain in last 28 days (lb.)	37·6	37·4	40·3	43·4

From these figures it can be seen that the high oat content of the ration caused it to be unfavourable for young pigs, but highly satisfactory results were obtained when the pigs were over a weight of approximately 100 lb.

In an earlier experiment (2) with young pigs, two rations containing a high proportion of crushed oats and boiled potatoes were tested against a standard ration. The composition of the rations and the results were as follows :—

TABLE II

	Group I	Group II	Group III
Rations fed (*ad lib.*)	parts Barley meal . 65 Sharps . . 25 Fish meal . 10	parts Barley meal . 25 Sharps . . 20 Crushed oats 30 Boiled pots. . 60 Sep. milk . 20 Minerals . 2	parts Barley meal . 25 Sharps . . 20 Crushed oats 30 Boiled pots. . 60 Ex. soya bean cake . . 13 Minerals . 3
No. of pigs in groups	12	12	6
Av. initial lot (lb.)	47·3	47·3	47·5
Av. final wt. (lb.)	100·0	104·2	99·3
Av. gain per pig per day (lb.)	1·05	1·14	1·04
Lb. S.E. per 1 lb. gain	2·25	2·11	2·13
Feed cost per 1 lb. gain (d.)	3·34	2·76	2·79

These results indicate that crushed oats may form up to 30 per cent. of the total ration for pigs under 100 lb. even when the ration contains a high proportion of boiled potatoes.

A ration of two parts crushed oats and eight parts boiled potatoes was tested on pigs over 200 lb. and fattening sows. The results showed that satisfactory gains could be made without the ration being supplemented by more expensive feeding stuffs (gains of 1·23 to 1·90 lb. per animal per day were obtained).

The first experiment reported in this paper was repeated, Sussex ground oats being used in the place of crushed oats, with the following results :—

TABLE III

	Standard Ration		Sussex Ground Oats Ration	
	A	B	A	B
Av. init. wt., 24/11/31 (lb.) .	51·3	50·2	50·8	51·2
Av. wt., 19/1/32 (lb.) . .	107·1	104·9	105·6	105·6
Gain in 56 days (lb.) . .	55·8	54·7	54·8	54·4
Av. final wt., 10/2/32 (lb.) .	135·6	134·2	132·9	135·5
Gain in last 21 days (lb.) .	28·5	29·3	27·3	29·9

These results show that Sussex ground oats may form up to 70 per cent. of a ration for young pigs, although its use is not to be recommended on account of its price. The cost of production per 1 lb. live weight increase is shown in the following summary of the whole experiment :—

TABLE IV

	Standard Ration		Sussex Ground Oats Ration	
	A	B	A	B
Gain in 77 days (lb.) . .	84·3	84·0	82·1	84·3
Av. gain per pig per day (lb.)	1·10	1·09	1·07	1·10
Food per 1 lb. live w. gain (lb.)	3·40	3·41	3·55	3·44
Food cost per 1 lb. live w. gain (pence) . .	2·51	2·51	3·57	3·46

The high cost of the Sussex ground oats (10s. 6d. per cwt.) is one of the main factors in the large difference in the cost of production between the groups fed on the standard and experimental rations.

In order to discover whether the removal of the husk from oats would improve its value, oats in the three forms of (*a*) crushed oats, (*b*) husked oats, and (*c*) oatmeal were fed at the rate of one-third of the total ration in conjunction with the same basal ration to three groups of young pigs. The results were :—

TABLE V

	Av. gain per pig per day (lb.)	Food consumed per lb. l.w. increase (lb.)	Cost per 1 lb. gain (pence)
Group *a* Basal + Crushed Oats .	1·11	3·80	3·38
,, *b* ,, + Husked Oats .	1·05	3·55	3·89
,, *c* ,, + Oatmeal . .	1·10	3·48	3·89

From these figures it can be seen that the crushed oats gave satisfactory results, and although the food consumption per lb. live weight increase was greater than in the two other groups, the cost of refining the oats to remove the husk was not economic.

Oatdust, a by-product of the oatmeal industry, with an approximate analysis of

9·58 moisture ; 5·00 ash ; 9·85 protein ; 5·1 fat ;
17·78 fibre ; and 52·69 carbohydrates

is also used in pig feeding, although the fibre content is high. Two experiments were carried out to find whether this product had any economic value.

In the first experiment five groups of pigs received rations coning respectively 0, 10 per cent., 20 per cent., 30 per cent. and 40 per cent. of oatdust. The results given below show that the successive increase of oatdust in the ration retarded the rate of growth of the animal; the depression in growth was so marked that although the oatdust cost only 1s. 1d. per cwt. and the control ration 6s. per cwt., the cost of production was lowest in the group which received the basal ration only.

TABLE VI

GROUP	1	2 (10 % Oatdust)	3 (20 % Oatdust)	4 (30 % Oatdust)	5 (40 % Oatdust)
Av. daily live w. gain (lb.)	1·36	1·22	1·09	1·05	0·88
Food per 1 lb. live w. gain (lb.)	4·02	4·51	5·04	5·21	6·20
Food cost per 1 lb. live w. gain (pence)	2·68	2·77	2·88	2·71	2·93

To test whether steaming the oatdust would improve its value, a second experiment was performed in which a ration containing 20 per cent. of oatdust was fed to three groups of pigs either dry, wet or steamed as compared with a control group which received the basal ration only, with the following results :—

TABLE VII

GROUP	1 (Control)	2 (Dry)	3 (Wet)	4 (Steamed)
Av. daily live w. gain (lb.)	1·54	1·08	1·16	1·26
Food per lb. live w. gain (lb.)	3·77	5·26	4·88	4·51
Food cost per lb. live w. gain (pence)	2·57	3·01	2·80	2·59

Steaming the oatdust improved its value, as compared with feeding it in a dry or wet state, but did not make it an economical pig food. Although the cost figure shown in the Table approximates to that obtained for the control-fed pigs, it must be stated that the cost of steaming has been omitted.

Summary.—These results show that oats in any form except oatdust may be used as a suitable pig food. Crushed oats have proved suitable for young fattening pigs if fed up to 30 per cent. of the total ration for pigs under 100 lb. live weight. This proportion may be increased to 70 per cent. for pigs over 100 lb. live weight.

Sussex ground oats have been fed at the rate of 70 per cent. of a ration for young pigs under 100 lb. and satisfactory gains obtained, although the cost of production was high. Dehusked oats and oatmeal have not proved superior to crushed oats when forming one-third of the total rations, and were more costly than the latter food.

Oatdust is not a suitable food for fattening pigs.

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Sheep-Maggot Flies—an Investigation of the Situation in Scotland

FROM the National History Department, University of Aberdeen; communicated by Professor James Ritchie, M.A., D.Sc., F.R.S.E.

Sheep-maggot flies are now established pests in most of the sheep-raising countries of the world. In some countries, such as Australia, their ravages are so serious that a team of Government research workers concentrates its whole attention upon the problem, endeavouring to find some means of relieving the sheep-farmer from the loss caused to his flocks. The breed in which the Australian wool-producer specialises, the Merino, is, on account of the nature of its fleece and the conformation of its body, particularly liable to blow-fly attack. The wrinkled crutch provides an area of the fleece which in ewes is perpetually soaked with urine, and therefore specially attractive to the flies; so that the surgical removal of these skin folds in young lambs is actually practised by some Australian breeders. The difficulty of control is further increased because of the extent of the sheep-ranges, and the consequent impossibility of removing or destroying carcases of sheep, which come to act as breeding reservoirs for the flies.

In Scotland the problem may not be so serious as it is in Australia or South Africa; but it is, undoubtedly, of considerable economic importance. On the wilder sheep pastures ailing sheep, seeking concealment amongst bracken, may die unobserved; even where the fly pest is not regarded as serious the daily occurrence of maggots in the flocks necessitates constant extra care during the summer months, and this alone prevents more serious financial loss through loss of condition and death.

Two different species of flies are mainly, or perhaps wholly, responsible for sheep-maggots in this country: the Blue Bottle (*Calliphora erythrocephala*), and the smaller Green Bottle (*Lucilia sericata*). Of these the latter is much the more important, both on account of the number of sheep struck, and the resulting effects of the strike. Its maggots, instead of feeding mainly on the surface of the skin, and only rarely piercing it to enter the tissues below, as is the habit of Blue-bottle maggots, almost invariably, and usually at a very early stage, pierce the skin to feed on the fat and muscles lying underneath.

The sheep-maggot pest in Scotland was investigated some time ago by Dr R. Stewart MacDougall of Edinburgh, and the results of his studies were published in the *Transactions of the Highland and Agricultural Society* of 1909. He bred out flies from maggots obtained from sheep struck in many parts of the country, and established the fact that the above-mentioned two species were responsible for the damage. The general information supplied to him by farmers also indicated that the flies were apparently altering their habits, and were extending their activities to the higher hill grazings, where flocks had hitherto been immune. This development seems to have taken place in the early years of this century, and to have spread from the south northward. At the time when he published his findings, twenty years ago now, the hill pastures of the far north were still free from the sheep-maggot pest. It is a rather remarkable fact that the great spread of the pest in Australia has also taken place within the last thirty years, and that there also the British Green-bottle fly, *Lucilia sericata,* which has probably been introduced accidentally from this country, is one of the species concerned.

Since Dr MacDougall's survey no investigation of the Blow-fly situation has been carried out in Scotland, and no data have been collected to discover the distribution and economic importance of the pest at the present day. The Natural History Department of Aberdeen University, in co-operation with the Rowett Research Institute, is undertaking an investigation into the problem. It is intended to make a survey of the conditions regarding the pest in different parts of the country, with the view of estimating the financial losses to the sheep industry caused by it, and of finding out the relative severity of the fly in different districts, and its preferences (if any) for different types of country and pasture, different altitudes, and different breeds of sheep. Experiments will be carried out through the season on the Rowett pastures, where accurate data of the incidence of strike will be kept, in an effort to discover the causes of strike. Are sheep attacked simply because there happens to be an abundance of flies at any particular time ; or is the attack associated with special climatic conditions, or with the condition of the fleece itself, as recent work in Australia seems to indicate is the case in Merino flocks ? The results of these experiments should suggest the lines along which future research can most profitably be carried out. The life-histories of the flies responsible for strike, and their natural breeding grounds and places of hibernation or over-wintering, will also be investigated.

Without the co-operation of farmers and breeders in different parts of the country a general survey of the pest would be impossible, for upon direct information from the flocks our preliminary information as to the distribution of the flies, and their economic importance at the present time, must depend. It is proposed therefore at the end of this season to circulate a questionnaire as widely as possible, asking farmers for information as to the occurrence of maggots among their flocks during the present summer, the month or months when sheep strike is most prevalent, the type of pasture on which the sheep are run, the breed of sheep most affected, and the financial losses involved during the course of the season, either directly through deaths and loss of condition, or indirectly through additional labour and the cost of treating affected sheep. It is only from accurate data of this kind, supplied by individuals in different districts, that a comprehensive picture of the status and distribution of the pest can be built up.

Since this preliminary investigation is of vital importance, it is hoped that sheep farmers will assist the investigation by taking special note during the present season of the incidence of fly strike in their flocks, and also of any special points of interest, such as the weather conditions at the time, the position of the body on which sheep are struck, the class of animal affected, etc., all of which may be of significance. The Natural History Department will also welcome information, at the time, of the occurrence of unusually severe strike, which deserves investigation on the spot; and they would be glad to receive living maggots taken from sheep, which will be bred out to determine the species of fly responsible, for comparison with results of earlier work. Specimens or information should be addressed to Professor James Ritchie, Marischal College, Aberdeen.

Reviews

The Nutritive Properties of Milk in relation to Pasteurisation. J. D. Stirling, B.Sc., Ph.D., and J. H. Blackwood, B.Sc., Ph.D. Bulletin No. 5, The Hannah Dairy Research Institute.

ONE of the most vexed questions connected with our milk supply is that of the advisability of general pasteurisation. The question has recently been raised in an acute form in proposals made by public health authorities in Manchester and elsewhere for powers being given to civic bodies of making compulsory this treatment of their local milk supplies. The appearance of such an authoritative review of the subject as is the Bulletin of the Hannah Dairy Research Institute is accordingly specially timeous. It is not an *ex parte* argument for or against pasteurisation: its purpose is to review the evidence submitted on both sides and to subject it to careful analysis. In the course of their review the authors make reference to nearly two hundred original papers, and many more appear to have been consulted: so that the investigation may be regarded as exhaustive so far as published research is concerned. It should moreover be of great value to future workers inasmuch as in their discussion of the principles involved the authors make useful suggestions for further research on definite lines.

As is pointed out by Dr Wright in his introduction to the review, it is confined to the nutritional aspects of pasteurisation, and there are other factors to be considered in deciding the general question. For example, there can be no doubt about the efficacy of proper pasteurisation in helping to control milk-borne disease, notably in the bulked supplies of large urban centres. And, on the other hand, it would be a thousand pities if compulsory pasteurisation came to be regarded as a substitute for the precautions necessary to obtain the general production of clean, healthy milk. To attain that result ought to be the aim of all civic control measures, as well as that to which the energies of every conscientious producer should be directed.

The pamphlet in the main is confined to the consideration of the effects of the "holding" process of pasteurisation, in which the milk is brought up to a temperature of 145°-150° F. and is maintained at that temperature for 30 minutes, after which it is cooled.

Part I examines the effects of this treatment on the physical and chemical properties of milk, and Part II deals similarly with the accessory milk constituents or vitamins, while the succeeding section investigates the supposed effects of heat on its susceptibility to enzyme action, on its bactericidal properties, and on the efficiency of its antibodies and its lactic acid bacteria.

The physical and chemical changes brought about by heating are said to be mainly the coagulation and partial decomposition of a small quantity of lactalbumin, and a slight alteration in the balance of calcium and phosphate. As to the properties referred to in the third section, the authors are of opinion that, on the evidence of past work, no weight can be given to the suggestion that the pasteurisation of milk affects them deleteriously.

The only vitamin shown to be destroyed by pasteurisation is Vitamin C—the anti-scorbutic factor, and the destruction is only partial. Of the changes effected by heating, this is the only one which produces well-defined symptoms in milk-fed young animals; and the deficiency in nutrient content of the milk so caused can be readily supplied by the addition to the diet of an anti-scorbutic, such as orange juice.

The incidence of vitamin deficiency diseases in relation to the feeding of pasteurised milk is considered at some length, and according to the authors there is no evidence of any deficiency disease resulting from such feeding, beyond that mentioned as connected with the diminution of Vitamin C.

In what is perhaps the most interesting chapter of the Bulletin, the physiological aspects of the feeding of pasteurised milk are examined, the problem being to discover whether the slight physical and chemical changes noted as resulting from heat treatment are of any physiological importance in relation to (*a*) the supply of energy; (*b*) the building up of soft tissues; and (*c*) the building up of the skeleton. It is taken for granted that the energy value remains the same, and that the feeding value of the milk fat and the lactose is likewise unaffected. The effect upon the proteins and the inorganic constituents has been the subject of considerable investigation, and much of this is passed under review. Some of the conclusions arrived at by various experimenters are shown to be unwarranted. The authors suggest that the answer to the question—Does the pasteurisation of milk affect its nutritive value?—can be obtained only by feeding experiments on a large scale when methods of statistical analysis are employed. Attention is called to the inconclusive nature of the results of certain experiments where the numbers of the experimental animals were too small to justify the conclusions supposed to be reached, and caution is advised in applying results obtained in feeding one species of animal to the case of other species. Suggestions are offered for the proper control of large-scale experiments to be carried out at different centres, so as to ensure a sufficiency of numbers of animals under observation.

Experiments so far carried out in the feeding of school children have not been so arranged as definitely to compare the effects of feeding (*a*) raw and (*b*) pasteurised milk. Nevertheless, the authors reach the conclusion that "there do not appear to be any good grounds for the belief that pasteurised milk is a less valuable component of the diet than raw milk for children who satisfy the bulk of their requirements from sources other than milk." On the other hand, they state that "there are strong grounds for the belief that infants can satisfy all their requirements on diets of adequate amounts of pasteurised milk, provided that extra Vitamin D and, of course, Vitamin C are added to the diet."

There will be general agreement with the opinion expressed that the subject is one demanding further investigation, especially in regard to the metabolism of infants, and the requirements of children for calcium and phosphorus at various stages of growth.

The Hannah Research Institute may be cordially congratulated on the issue of a highly useful review of experimental work in this field. Both in the care and accuracy of the examination of recorded results, and in the literary presentation of the findings, the pamphlet is a model of its kind.

A melancholy interest attaches to the publication of the *Bulletin*, from the fact that one of the authors—Dr J. D. Stirling—died in February last year after a short illness. His death is a distinct loss to agricultural research in Scotland.

The Purchase of Milk on a Quality (*Composition*) *Basis*. Harold T. Cranfield and John W. Blood. Bulletin No. 28, Midland Agricultural College.

Purchasers of milk for manufacturing purposes have long realised that the composition of milk should be taken into account in fixing the price to be paid for it, and in most dairying countries some such practice is in operation. Milk for immediate liquid consumption, however, is seldom dealt with in this way, and the authors of this pamphlet argue—at least in the case of the larger purchasing and distributing agencies—if payment were made on a quality basis the extra cost of testing would be more than repaid and the practice would result in a general improvement of the supply. Under the present custom of paying a flat rate to all producers no encouragement is given to the dairyman who breeds and feeds for quality in his milk, nor is the man who looks only to quantity in any degree discouraged.

Some account is given in the Bulletin of systems of differential payment in operation in certain countries either for consumption milk or for manufacturing milk. The schemes may be summarised as follows :—

1. Butter manufacturers pay per lb. of butter fat.
2. Cheesemakers have not evolved a satisfactory system since the yield of cheese is not strictly proportionate to the content of fat, or of solids not fat, or of total solids : but they are agreed that payment according to quality, as judged by quantity of cheese produced, is desirable.
3. In the case of milk for immediate consumption there has been very little application of the principle of differential payment. Such plans as have been tried have based their payments on fat content alone, and in no case has value been given to content of non-fatty solids.

The pamphlet is a plea for the institution of payment according to the total food value of the milk.

An account is given of an investigation carried out by the authors, in conjunction with the manager of the Lincoln Co-operative Society's Dairy, over a twelve months' period. The scheme of payment for milk supplied to the Dairy, as agreed upon between the producers and the Society, provided for a variation of one-tenth of a penny per gallon for each one-tenth per cent. variation of fat content from the standard : the standard agreed upon being the average percentage of fat in the whole of the milk received at the Dairy each month.

To the data obtained in the course of the working of this arrangement the investigators applied an imaginary scheme of payment calculated on the food value of the milk supplied by each producer. The food valuation was determined by the calorific values of the fat and non-fat solids contained : 1 lb. of fat being taken as equal to 4218 calories, and 1 lb. of other solids as equal to 1702 calories. At a standard price of 1s. per gallon, 1 lb. of fat on this basis has a value of 16·492 pence, and 1 lb. of other solids has a value of 6·655 pence.

A table gives the prices actually paid to each supplier on the basis noted above and gives also the payments which would have been made on the complete quality basis. The results are undeniably suggestive, and a good case is made out for purchase by quality in the sense used by the investigators.

Principles of Fruit Preservation: Jam Making, Canning, and Drying. T. W. Morris, M.A. Chapman & Hall, 15s.

This is one of a series of monographs issued under the editorship of Dr Howard Tripp. Their purpose is to summarise for the expert in related fields of science, or for the interested layman, the latest results of research on special lines of Applied Chemistry. Mr Morris's monograph is based on nine years of research and factory experience in the fruit-preserving industry and five years' research on special problems of fruit canning ; and it is safe to say that no research worker on the problems connected with these industries, and no one engaged in them commercially, can afford to neglect the wealth of accurate knowledge and the detailed description of experimental work and its results contained in this volume.

The chemical composition of the commoner fruits is dealt with and tables are given showing the proportions in which the various constituents are present in different fruits. In the section dealing with Jam-Making much space is naturally devoted to a consideration of the pectic substances of plants, since it is due to the presence of these that fruits can form jellies when boiled with sugar. A highly technical account is given of the methods of measuring the *gel* strength of the pectin-sugar-acid combination, and in this connection reference is made to the useful original work of Dr W. G. Ogg, now of the Macaulay Institute.

Much practical information is given on technical matters and processes of manufacture of jams and jellies, and the section dealing with these points is well worth attention by commercial jam makers. One of the main difficulties of the industry is that of using the fruit when it is fresh, or, alternatively, of keeping it in good condition until it can be dealt with ; and an interesting description is given of various processes and treatments for preserving it temporarily, including the use of sulphur dioxide, which is perhaps the simplest and commonest practice. There appear to be possibilities of a satisfactory solution to this problem in cold storage or freezing.

Without going into details of machinery the methods of manufacture of jams and jellies are noted, and reference is made to the standards agreed upon by the Food Manufacturers' Federation and the Society of Public Analysts. Problems of storage are discussed and suggestions made for the prevention of moulds and yeasts. Hints are likewise given on the chemical control of jam and jelly making.

Since the invention by Nicholas Appert in 1804 of the method of preserving foodstuffs by hermetically sealing the containers, and sterilising them by heat, the procedure has developed into a huge industry, notably in America ; and the systematic examination of the processes here undertaken is accordingly of great value. The problems connected with each stage are noted—sorting, grading, washing ; peeling, coring, skinning, etc. ; filling into cans ; syruping ; exhausting of air ; lidding and sealing the cans ; processing by heat ; cooling ; storing—all of them have their special difficulties, and the monograph quotes for guidance the results of much experimental work. Spoilage, which is due mainly to the growth of micro-organisms in the jam, to corrosion of the tin or iron of the can, or to over-filled, dented, or externally musty cans, is fully examined and advice is offered for its prevention. Detailed instructions are given for the technical examination of canned goods for purposes of factory control.

The principles of Fruit Bottling are much the same as those of Canning, but there are special precautions to be taken to secure a pleasing appearance of the contents, to prevent leakages and breakages, and to preserve the natural colours of the fruits.

Drying of fruits depends for its effectiveness on reducing their water content to a point at which moulds, yeasts, or bacteria can find in them no suitable medium for growth. The main problem is to avoid either under-drying or over-drying, and methods are described for determining the moisture content, and so controlling the quality of the output. The safest method of drying is the natural one of sun-drying, but that is practical only in tropical countries. The processes of artificial dehydration in use in various temperate countries are passed in review, as these are applied to different fruits, and a chapter is devoted to the scientific principles of dehydration. The storing of dried fruits is dealt with.

Finally, certain considerations common to all preserved fruits are discussed, such as discoloration in fruit products and the presence or absence of vitamins in canned and dried fruits. Apparently in regard to the latter topic much research work remains to be done. The book can be heartily commended to the notice of all who are interested in the industries involved.

The Comparative Values of Flaked and Ground Maize

I. W. Rhys.

National Institute of Poultry Husbandry, Salop

Owing to the necessity for reducing labour costs, dry feeds have now largely superseded cooked foodstuffs in mash mixtures for poultry feeding. The belief, however, is still widely held that cooking renders the foodstuffs more digestible, and flaked maize, which is sold in a form already cooked, is extensively used in both dry and wet mashes.

The results of experimental laboratory work have indicated that this food was actually more digestible, and the following trial was carried out for the purpose of testing whether these results would be borne out in practice.

The experiment was conducted in two parts, one with pullets in 1929-30, and the other with the same birds as hens in 1930-31.

The stock at the commencement was 40 White Leghorn pullets per pen, the birds being divided evenly according to breeding, age, maturity and body weight. All were trap-nested throughout the experiment, and records of food consumption and egg weight were made.

The experimental pens, each 14 feet by 12 feet, with a grass run 24 feet by 50 feet, were part of a long laying house. Equipment of pens, feeding and management were similar in both cases with the exception of the foods under comparison. Dry mash was available at all times, together with a constant supply of clean water, flint grit and oyster shell. The all-mash system of feeding was used, so that there was no scratch grain throughout the experiment. During the first year the birds were confined to the house in winter, from 25th October to 14th March, and for this period food consumption was aided by the use of electric lights, which were switched on at 4 a.m. and off at daybreak. Whilst in confinement all pens received 2 lb. of green food per pen daily.

Throughout both years the rations were as follows :—

Basal mash (*all parts by weight.*)

49	Yellow maize meal.
14	Broad bran.
14	Thirds.
6	Meat and bone meal.
6	Dried skim milk.
6	Ex. soya bean meal.
1	Salt.
2	C.L.O.
2	Ground limestone.

The flaked maize pen received the same ration with 49 parts of flaked maize replacing 49 parts of maize meal, care being taken to ensure that both foods were prepared from the same sample of maize.

During the first year the average price of mashes was 12s. 9¾d. for the basal mash and 13s. 4d. for the flaked maize mash. The average price of the ingredients was maize meal 9s. 5d. and flaked maize 10s. 10d. Food prices tended to decrease throughout the experiment and each month showed a slight decrease over the preceding period.

The results of feeding on egg production showed that at no period did the production of the flaked maize pen exceed that of the maize meal group. The average production was good, but it was unfortunate that an outbreak of nutritional roup occurred in a pen adjacent to the flaked maize group. The disease was carried by the attendant throughout the house, but apart from the serious drop in production in this pen during the fifth period the general results were not seriously affected. In discussion it is proposed to ignore this one period of low production, but it is impossible to make allowances for it in the tables of figures.

In amounts of food consumed there is no significant difference between the two pens, but consumption was always slightly higher in the flaked maize group. The general egg size of both pens was not particularly good, but again there was no difference. In health, with the exception of the outbreak of nutritional roup, both pens were satisfactory. Three birds died during the course of the experiment, one in the maize meal pen and two in the flaked maize group, but none of these deaths can be attributed to the foods under consideration.

TABLE I

Summary of Results 1929-30 ; *Individual Bird Basis*

	Maize Meal	Flaked Maize
Av. no. of birds . . .	39·47	39·13
Yearly per cent. production .	54·90	46·26
Av. egg weight, in drams .	31·64	31·45
Eggs per bird . . .	184·46	155·44
Income	26s. 5·28d.	21s. 7·56d.
Food cost	8s. 9·96d.	9s. 4·80d.
Margin	17s. 7·32d.	12s. 2·76d.
Cost of lighting . . .	4·90d.	5·00d.
Body wt. at beginning .	3 lb. 2·4 oz.	3 lb. 2·3 oz.
Gain in wt. . . .	14·36 oz.	12·19 oz.

It will be apparent that under the conditions of this experiment the more expensive flaked maize did not give such satisfactory results as the cheaper maize meal.

Owing to the outbreak of nutritional roup during the first year it was felt desirable to reduce the numbers of birds to 30 per pen for the second part of the experiment in 1930-31.

The housing and equipment were the same as for the pullet year and the mashes were of the same composition. An alteration was made in the management. Lights were used in the evening instead of the morning, and as an additional aid to food consumption wet mash was fed during the period of lighting. The lights came on each evening at 9 p.m. ; wet mash, formed by sprinkling the mash in the hopper with water, was available at this time. At 9·45 p.m. the lights were dimmed to induce the birds to go back to the perches and at 10 p.m. the lights were switched off completely. This form of management was not commenced until the birds had completed the moult and extended from 2nd December to 6th April. Green food was fed throughout the winter at the usual rate.

A comparison of food prices in the two years shows a considerable decline in the second period, the basal mash averaging 10s. 9d. per cwt. and the flaked maize mash 11s. 2d. ; maize meal was 6s. 8¼d. per cwt. and flaked maize 7s. 10¼d. As in the first year there was a tendency towards cheaper feeding costs throughout the experiment. In examining the effect of feeding on egg production, it was again noticeable that at no time did the production of the flaked maize pen equal that of the pen receiving maize meal. In this year the difference was statistically significant.

Food consumption was similar in both pens.

One fact of particular importance was the sudden increase in production when lighting was commenced, the extent of the increase between the periods November to December and December to January being astonishing. The second year production of the basal pen is only 12 per cent. lower than that for the pullet year.

Health remained good, but the rate of mortality was higher than in the first year. In the maize meal group four deaths occurred ; three birds were killed as reactors to the agglutination test and the other death was due to an egg-bound condition. In the flaked maize group there were three deaths ; one resulted from a rupture of the bowel, one from peritonitis caused by degenerating egg material in the abdomen, and in the other case there was no examination.

TABLE II

Summary of Results, 1930–31

	Maize Meal	Flaked Maize
Yearly per cent. production .	42·874	35·479
Av. egg wt. in drams .	33·13	32·42
Eggs per bird . . .	144·057	119·209
Income	15s. 1·44d.	11s. 9·82d.
Food Cost	6s. 8·14d.	7s. 0·57d.
Margin	8s. 5·31d.	4s. 9·25d.
Body wt. at start . .	4 lb. 1·56 oz.	3 lb. 14·52 oz.
Loss in wt. . . .	0·14 oz.	0·59 oz.

Hatchability tests were carried out to see if the feeding had any influence on the fertility and hatchability of the egg produced. The eggs set were selected from those laid on the days preceeding the days of setting, and for the purpose of the experiment only cracked eggs were excluded.

In all, seven tests were made, and in view of the uniformity of the results it is not felt worth while to reproduce the results in full.

	Maize Meal		Flaked Maize	
Eggs set . .		311		311
Clear . . .	13	4·2 per cent.	11	3·5 per cent.
Early dead germs .	18	5·8 ,,	17	5·45 ,,
Late dead germs .	62	20·0 ,,	35	11·2 ,,
Hatched . .		218		249

	Maize Meal	Flaked Maize
Hatched as percentage of total eggs set . .	70·0 per cent.	79·85 per cent.
,, as percentage of fertile eggs	73·2 ,,	82·75 ,,

From this table it can be seen that the rations fed did not influence the hatchability of the eggs produced. It should be noted that during the hatching period the birds were under artificial light.

The results of the experiments with pullets and hens agree very closely. It is clearly shown that under the conditions of the experiment the preference for flaked maize over maize meal is not justified in rations for laying and breeding stock.

Cultivation and Management of Potato Varieties

A. Millar, B.Sc.

One notable aspect of potato culture in Scotland is the large number of varieties under field cultivation. In 1932 there were thirty-three varieties with an acreage of 100 or more, while there were many other varieties grown on a small scale varying between ½ acre and 100 acres. Most of the varieties in the latter class have failed to attract widespread attention owing to one or more serious faults or to lack of certain desirable qualities, but a few of them are new varieties recently introduced to commerce and perhaps destined to attain to popularity as they become known and sufficient stocks become available at a normal price. This large number of varieties is accounted for not only because some have a special feature or features which make them particularly desirable in certain localities, but also because potato varieties vary greatly in their performance from place to place and from year to year. Soil and climate are potent factors in determining these differences, but methods of cultivation and general management are also responsible for differences which arise on different farms. These differences are in part due to lack of general understanding that not all varieties should be cultivated or managed alike. True, a number of the popular varieties are not specially exacting in their requirements and call for no extraordinary precautions in their cultivation and management. This very adaptability naturally has tended to increase their popularity, even although in other respects they may not be so desirable as less adaptable varieties. Among the varieties calling for no special consideration the principal are British Queen, Great Scot, Arran Chief, Up-to-Date and Kerr's Pink. The less adaptable varieties have special features, such as early bulking, excellent table quality or suitability for the English market, which make them particularly desirable from the farmers' point of view. The extent of their popularity in some cases has undoubtedly been restricted because of losses incurred due to lack of understanding of their peculiarities. These losses could be reduced if all farmers would carefully study the habits and characteristics of the varieties which they grow. A list of some less adaptable varieties is given below, together with notes on the special treatment or attention which each variety requires. In general these notes have particular reference to combating the common blight and to endeavouring to ensure that the appropriate size of tuber is produced. The recommendations may not be suitable for general adoption, as their use will depend upon the conditions under which the varieties are grown and the purpose for which the potatoes are required—whether ware or seed. In regard to these recommendations, it should be understood that spraying against blight is considered to be a regular procedure and is not mentioned in these notes unless the circumstances specially require it.

Ninetyfold and May Queen.—These varieties, being grown in Scotland only for seed, should be planted in sandy loam which is not only more suitable for their growth on account of its fine tilth, but also produces a skin on a tuber which is more resistant to infection by blight. When the tubers have reached a suitable size for seed the haulms should be either cut level with the ground or destroyed by burning with a strong solution of copper sulphate, 14 lb. per barrel of 40 gallons of water. Either operation must be carried out before blight appears on the haulms. The tubers should not be lifted until at least a fortnight after the death of the haulms. Lifting should be done either with graips or with a plough to prevent damage to the tubers. Dry rot of the tubers is a trouble found particularly in kidney-shaped first early varieties. The disease follows as a result of the tubers being damaged by blight, mechanical operations or frost. Prevention of such damage is, therefore, the major part of the prevention of Dry rot. When lifted dry in good condition and free from any form of damage, tubers of first early varieties keep at least as well in small, well-ventilated pits as they do in boxes. Other earlies such as Duke of York, Witchhill, Sharpe's Express, Arran Crest and Catriona, although not quite so susceptible to blight, should be treated in the same manner when grown for seed.

Epicure.—To produce an early crop the seed must be lifted early in July and put into sprouting boxes to green. Such tubers produce good sprouts during the winter. This early sprouting is probably induced by the exposure of the tubers to the heat of the latter part of the summer and autumn. Tubers which have been lifted in September do not sprout sufficiently before planting time, which in early districts commences at the end of February. Insufficiently sprouted tubers produce crops as much as a fortnight later than stocks from well-sprouted tubers. Stocks are considered to acquire earliness by sojourn in an early district. The above remarks apply also to all other varieties which are grown for the first early ware trade.

Arran Crest.—This variety is the earliest in commerce if treated for the ware trade as advised for Epicure. As the haulms are small, the tubers should be planted not more than 9 inches apart in drills 25 inches apart. This provides cover and keeps down weeds.

Arran Pilot.—The haulms of this variety are of a spreading nature, differing from the upright habit of growth of Epicure. Owing to its branching habit it is more liable to be blown about by the wind. The plants should, therefore, be kept well earthed up right through the season. It is noteworthy that in Donegal, which is a storm-swept county, in the early summer all the potatoes are kept well earthed up. Arran Pilot is a very quick sprouter, and therefore, during storage, the tubers should be kept exposed to light in order to prevent the sprouts from becoming too long.

Arran Consul.—This variety sprouts very slowly and the first shoots are late in showing above the ground. On this account cultivation is often delayed, with the result that weeds thrive, a condition which is aggravated by the subsequent lack of cover for some time. In reality the tardy appearance of the first shoots is an advantage as the drills can be harrowed down and earthed up several times, if the weather permits, without risk of damaging the young shoots. In this way tilth is preserved and weeds subdued. While Arran Consul can grow luxuriantly, as a rule the haulms are less spreading than other main-crop varieties. Because of this, and also because of the open nature of the foliage, the plants can be grown closely together without loss of size of tubers. Another reason why it should be close planted is that the tubers cluster closely round the root and do not spread over the drill. As a matter of fact, Arran Consul is notable for the small amount of seed and chats which it produces.

Arran Banner.—With normal manuring and spacing on good land the tubers of this variety often grow too large. On such land the spacing should be reduced and the artificial manures restricted to half the usual quantity. Arran Banner is really a cheap crop to produce, while on poor land it will succeed where some varieties would grow mostly seed and chats. If the haulms become affected with blight the crop should not be lifted while the disease is active, as the tubers are specially liable to become affected from spores falling on them at the time of digging. The tubers should keep soundly if they are not lifted until the haulms have been destroyed or have withered completely.

Majestic.—In Scotland this variety is grown almost entirely as a seed crop. Ware sized tubers are not wanted. Owing to its proneness to produce large tubers, the advice regarding Arran Banner would apply here also, but further steps could be taken to ensure a crop mostly of seed size. When the tubers are a suitable size the haulm should either be cut or destroyed by burning with a strong solution of copper sulphate. Owing to the strength of the haulms this operation is more difficult to perform than in the case of early varieties, but it has been tried and found practicable. It is often considered a good plan not to combat an attack of blight on the haulms by spraying with Burgundy or other similar mixtures. The blight in such cases is allowed to destroy the haulms, and it does not affect the tubers if these are left in the soil until the haulms are absolutely dead. In regard to storage, the tubers, owing to their sappy composition, should be kept in pits which are small and well ventilated in order to prevent heating. Stocks of this variety built up by unit selection and isolation are now available, which are a great improvement on the commercial stocks as regards freedom from leaf roll and mosaic.

King Edward.—This is a variety which requires special precautions to be taken against an attack of blight, as the haulms and tubers are, for a main-crop variety, very susceptible to this disease. If spraying has not been carried out at the proper times it may be advisable to cut the haulms, or destroy them by burning with a solution of copper sulphate. The chances of the spores of the disease afterwards reaching the tubers are thereby reduced. A fault commonly found in King Edward tubers is that some or all of the eyes are " blind," due to the death of the buds in the eyes.[1] This results either in delayed sprouting or in complete failure to sprout. This condition is frequently associated with the disease known as Skinspot (*Oospora pustulans, O. & W.*). If blindness is suspected in a seed stock the tubers should be placed in seed-boxes, and only those tubers planted which have strong sprouts. Farmers should avoid planting this variety in any field from which previously a crop affected with " blind " eyes had been obtained.

Golden Wonder.—This variety has taken on a new lease of life owing to the successful efforts which have been made to produce healthy stocks by selection, roguing and building up. Growers are advised to obtain seed from these healthy stocks or from stocks derived from them.

A characteristic of this variety is that it needs a long growing period to enable the tubers to grow to a good ware size. The tubers should be sprouted before planting. Even slight chipping of the buds is an advantage if sprouting-boxes are not available. Generally the haulms lack nothing in vigour, but if the season is backward it is a good plan to apply one cwt. per acre of sulphate of ammonia to the drills before the final earthing up, care being taken to keep the manure off the foliage. Golden Wonder repays generous manurial treatment as it is a gross feeder. In order to ensure the production of full-sized tubers the grower should plant the seed at a distance of 18 inches apart, *i.e.* from the centre of one tuber to the centre of the next. The distance should be checked with a measuring-rod from time to time as planting proceeds.

It is not generally realised that the haulms of the older stocks of Golden Wonder are rather susceptible to blight, although, as is well known, the tubers are very resistant to this disease. If the haulms are cut down by blight in August or September the tubers will be small in size, as this variety makes most of its size when the plants are maturing. Therefore it is necessary to protect the haulms from destruction by blight by spraying them at least three times during the summer and autumn if the season is at all favourable to blight. Golden Wonder is a very easy crop to spray owing to its upright habit of growth. It is a remarkable fact that the new improved stocks of Golden Wonder are relatively resistant to blight in the haulms, and spraying is not so imperative in their case.

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[1] *Scottish Journal of Agriculture*, April 1932, pp. 191-195.

The use of 4 cwt. sulphate of potash per acre in the manure mixture, instead of the usual 1 or 2 cwt., has been reported to produce crops free from sprain on land where previously crops affected with sprain had been grown.

Dunbar Cavalier.—Some other varieties repay wide spacing and generous treatment owing to their tendency to produce a large number of tubers of seed size. Such varieties include Dunbar Cavalier, Ben Lomond, Tinwald Perfection, the Barron and Arran Luxury. These varieties can give excellent crops if treated in the manner recommended for Golden Wonder. Varieties tending to be "small in the run" are greatly favoured by a rainy season, the abundant moisture enabling the tubers to grow to a good size. A similar result can be obtained if a good supply of humus is maintained in the soil and the moisture thereby conserved.

The Conduct of Potato Trials.—Manuring is another factor which causes differences to occur between varieties. There is reason to believe that some varieties respond better than others to heavy manuring. For example, in experiments reported in the *Scottish Journal of Agriculture*, April 1933, it has been shown that King Edward did not respond to heavy dressings of artificial manure, whereas on the same fields Great Scot and Golden Wonder benefitted. Manurial experiments with different varieties of potatoes often give contradictory results because the optimum periods of growth of the different varieties may not coincide. A favourable spell of weather may benefit one variety and fail to benefit another, even although both are of the same botanical maturity. The fact that there is a difference in the rate of growth between some varieties in the same maturity group is of importance in the conduct of variety trials. The standard form of such experiments consists of growing rows of plots alongside each other. The quicker growing or stronger growing variety undoubtedly restricts the growth of slower growing varieties or of varieties with less luxuriant haulms. The random distribution of plots considered necessary in any variety trial renders it impossible to prevent unfair competition. The difficulty could be overcome by protecting each plot by two drills of the same variety on either side which would not be weighed, but this is impracticable with new varieties where seed is scarce and also—this applies to any variety trial—because much more ground would be required. The best test of the significance of any trial lies in the extent to which the results are confirmed in actual farming practice. In general a remarkable correlation in yielding capacity exists between the results of the Department's Potato Registration Trials and the results obtained by farmers who grew the same varieties as were under test, but it has been found that one variety which grew a normal size in the test has tended to be oversized in ordinary cultivation, and, on the other hand, that a variety which was undersized in the tests was of normal size in general cultivation. These discrepancies have been attributed to the effects arising from growing alongside each other varieties with inherently different capacities for rate and vigour of growth. The Scottish Potato Synonym Committee have therefore recommended that experiments be made this year with plots which have an air-space all round. This means leaving a space of about one yard unplanted all round the plot. Such space should eliminate competitive effects and give varieties a better chance to grow normally and produce their characteristic size of tuber.

Farm Wages in Scotland

INCLUDING the Agricultural Wages Table for Whitsunday 1933, the Department have issued every six months for ten years a tabular statement showing the estimated cash wages and value of perquisites given in each of approximately fifty districts into which Scotland has been divided for the purpose.

In practically all districts wages are the subject of free contract between the parties concerned, and in some cases difficulty is experienced in obtaining information regarding the engagements made. Until this year the cash wages given in the table were the approximate *average* weekly cash wages reported to be paid in each district, but in the table for Whitsunday 1933, a change has been made and the wages quoted are those said to be paid to the largest proportion of the employees in the various classes and not necessarily the average of the highest and the lowest.

At the Whitsunday hirings farm servants who entered into new engagements generally did so at a reduction in cash wages of from 2s. to 4s. per week, but the reports received from some districts indicate that on many farms wages were reduced all round by from 1s. to 3s. or 4s., whether the workers moved or not.

The pecuniary values of the allowances given in addition to cash wages, as reckoned at each of the last three terms, are as follows :—

	Whitsunday 1932	Martinmas 1932	Whitsunday 1933
Meal, per cwt.	17s.	17s. 4d.	17s. 4d.
Milk, per gallon. . . .	1s.	1s.	1s.
Potatoes, per ton . . .	£6, 10s.	£4s. 10.	£4, 10s.

	Whitsunday 1932	Martinmas 1932	Whitsunday 1933
Coal, per ton	£1, 15s.	£1, 15s.	£1, 15s.
House, per annum . . .	£6	£6	£6
Board and lodging for single men, per week . . .	14s.	14s.	14s.
Bothy accommodation, with attendance, per annum .	£9	£9	£9
Bothy accommodation, without attendance, per annum .	£6	£6	£6
Keep of cows and followers, per cow, per annum . . .	£10	£10	£10

The only items the estimated values of which show changes during this period are oatmeal and potatoes. During the last ten years the values put upon these two perquisites have varied considerably from term day to term day, according to the current market price. In the case of those men who receive a large proportion of their wages in kind this variation in values has caused substantial fluctuations in the estimates of the total remuneration received, although the actual benefit accruing to the worker from the allowances was unaltered. Since Whitsunday 1932, however, in order to avoid the fluctuations mentioned, the value adopted for meal has been the average wholesale price at Scottish markets for nine years, while the value put on potatoes has been the average price paid to producers for ware during the ten years ending 31st December 1932. In the case of potatoes the long-term average price is below the value put upon the perquisite at Whitsunday 1932, by £2 per ton. This would mean for men who receive one ton a year a reduction of about 9d. per week. In the case of meal the value has been increased by 4d. per cwt., which, for workers who receive 65 stone per annum, makes a difference in their wages of less than one penny per week.

The arithmetical averages of the Department's figures for the wages of married men are as follows :—

Average Weekly Earnings of Married Men

	Summer, 1932						Winter, 1932-33						Summer, 1933					
	Cash		Allowances		Total		Cash		Allowances		Total		Cash		Allowances		Total	
	S.	D.	S.	D.	S.	D.	S.	D.	S.	D.	S.	D.	S.	D.	S.	D.	S.	D.
Ploughmen	27	11	9	1	37	0	27	5	8	5	35	10	26	5	8	3	34	8
Cattlemen	28	8	9	6	38	2	29	1	8	5	37	6	27	3	8	8	35	11
Shepherds	28	0	11	0	39	0	27	10	10	2	38	0	26	5	10	0	36	5

The total earnings in each case shows a small reduction. In the winter of 1932-33 the total was reduced by from 8d. to 1s. 2d., and in the summer of 1933 further reductions occurred varying from 1s. 2d. to 1s. 7d.

Married Ploughmen.—The following table gives in round figures the weekly earnings of married ploughmen in summer 1930 and in summer 1931, in respect of 38 of the total number of 50 counties and parts of counties included in the more recent wages statements :—

County or District		Summer, 1932			Summer, 1933		
		Cash	Allowance	Total	Cash	Allowance	Total
		s.	s.	s.	s.	s.	s.
Wigtown		24	16	40	23	16	39
Kirkcudbright		30	5	35	28	4½	32½
Dumfries		32½	4	36½	32½	3½	36
Selkirk		31	7½	38½	28	6	34
Roxburgh		31	7½	38½	28	6	34
Berwick		30	7½	37½	28	6	34
Peebles		33	4	37	31	4	35
East Lothian		33	4	37	29	3½	32½
Midlothian		33	4	37	30½	3½	34
West Lothian		33	4	37	31	3	34
Stirling		38	6½	44½	38	6½	44½
Dumbarton	Lower Clyde Valley	37	3½	40½	37	3	40
Lanark (N.W.)		36	4½	40½	36	4	40
Renfrew		34	4	38	33	4	37
Ayr (N.)		34	10	44	33	9½	42½
Ayr (S.)		34½	4½	39	32½	4	36½
Lanark (S.E.)		34	4½	38½	30	4	34
Clackmannan		34	4	38	34	3½	37½
Fife (S.W.)		34	4	38	34	3½	37½
Fife (N.E.)		25	13½	38½	25	12	37
Kinross		26	12	38	26	11	37
Perth (S.E.)		27	11½	38½	25	10½	35½
Perth (Central)		27	11	38	25	10½	35½
Angus (S.W.)		27	11	38	24	10½	34½
Angus (N.E.)		26	13	39	24	12	36
Kincardine		26	12	38	21	11	32
Aberdeen (E.)		21½	11½	33	20½	11	31½
Aberdeen (N.E.)		21½	12	33½	19½	12	31½
Aberdeen (Central)		22½	11½	34	18½	11	29½
Aberdeen (S.W.)		22	11	33	17½	11	28½
Aberdeen (N.W.)		20½	11	31½	18½	10½	29
Banff (N.E.)		20½	11	31½	20	10½	30½
Moray		24	11	35	20	11½	31½
Nairn		21	13	34	20½	12	32½
Inverness (E.)		21	13	34	20½	12	32½
Ross and Cromarty (E.)		21	13½	34½	18	13	31
Sutherland		18½	14½	33	17	14	31
Caithness		16½	17	33½	14½	15½	30
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Average		28 0	9 0	37 0	26 1	8 5	34 6

The arithmetical average of the cash wages for these 38 areas is lower than last year by 1s. 11d., while the value placed on the allowances or perquisites is lower by 7d. Eight of the districts show the same cash wage as a year ago, the others showing reductions of from 6d. to 5s.

The range of the total wages, including cash and allowances, in the various divisions of the country is as follows : in the southern counties from 32s. 5d. to 42s. 5d.; in the Lower Clyde Valley, from 36s. 10d. to 40s. ; in the remainder of the central area from 31s. 11d. to 44s. 6d. ; and in the north-eastern and northern counties from 28s. 3d. to 32s. 5d.

Single Ploughmen.—The average wage of single ploughmen in the south-eastern counties is 30s. 5d., or 3s. less than last year. In the south-western districts wages vary from 23s. in Wigtown to 28s. in Kirkcudbright. In the Lower Clyde Valley and North Ayr the cash wage averages 15s. 8d., as compared with 16s. 8d. a year ago, with board and lodging valued at 14s. The average cash wage in the east-central division is 21s. 7d., or 1s. 7d. less than last year, while the allowances, valued at 6s. 7d., show no change. In the northern and north-eastern counties the average cash wage is 17s. 2d. and the value of the perquisites 12s. 3d. In Scotland as a whole a single ploughman's wage is 29s. (cash, 19s. 1d., and allowances, 9s. 11d.).

Women Workers.—Female dairy workers generally receive board and lodging, which have been valued at 14s. per week, and cash wages ranging from 9s. 3d. in Orkney to 17s. 8d. in North Ayr. In West Lothian a cash wage of 21s. is paid with no allowances. Other women's rates, including board and lodging or their equivalent, vary between 22s. 3d. in Orkney and 29s. in South-East Lanark. Women paid by the day generally receive from 3s. to 4s. ; in Wigtown, however, the wages paid range from 2s. to 3s., in South-East Perth from 2s. 6d. to 3s. 6d., in Stirling from 3s. to 5s., and in North-East Angus they are generally about 4s. 6d. Women paid by the hour generally receive from 4d. to 6d.

Boys.—At Whitsunday this year in some cases, where men were unwilling to accept a reduction in wages, boys were engaged instead, and received rather higher wages than had been general before. In most districts boys engaged for a six months' period receive cash wages as well as board and lodging. The cash payments vary, of course, according to ability and experience. Where both are given the estimated total wage ranges from about 21s. to 26s. 4d. In a few districts where cash wages only are paid the rate generally varies between 15s. and 18s.

Girls.—In the Lothians and Peebles girls generally receive about 14s. and in Roxburgh and Selkirk from 10s. to 15s. per week with no allowances. Where board and lodging are provided the estimated total earnings vary from about 20s. 6d. to 25s. 6d. per week.

Casual Workers.—Men are usually paid from 4s. to 6s. per day, and in some instances down to 3s. and up to 8s.; the weekly rate ranges from 26s. to 35s. Women are usually paid from 3s. to 4s. per day or from 5d. to 9d. per hour.

The International Year-book of Agricultural Statistics

THE International Institute of Agriculture at Rome has recently published the 1931-32 edition of the *International Year-book of Agricultural Statistics*, a volume of about 800 pages.

In the first part of the Year-book are classified the figures for area and population for 208 countries. The second part is composed of a series of tables comprising for nearly 50 countries the available data concerning the uses for which the total area is employed, the apportionment of cultivated areas between the different crops, agricultural production, numbers of the different kinds of live stock and the products derived from them. In the tables constituting the third part of the volume have been indicated for nearly 40 agricultural products the area, production and yield per acre in each country.

For each kind of live stock all available figures in the different countries have been grouped. A large part of the volume is devoted to statistics of the commercial movement of 43 vegetable products and 13 products of animal origin. The figures published relate to the imports and exports during the calendar years and for the cereals also during the commercial seasons.

It may be added that the tables of production and commerce not only specify details for each country, but also the totals for the different continents and hemispheres and for the whole world.

The part devoted to prices contains the weekly quotations of 25 agricultural products on the principal world markets; in the freights section will be found the quotations for the transport of wheat, maize and rice on the most important shipping routes; and in the section reserved for fertilizers and chemical products useful in agriculture are published statistics of production, trade, consumption and prices for 15 products. In the Appendix have been brought together special chapters on the distribution of agricultural holdings according to their size and mode of tenure. The Forestry Statistics have been extended and developed and will be published in a separate volume under the title of: *International Year-book of Forestry Statistics*.

Agricultural Conditions

THE weather during March was on the whole remarkably mild, dry and sunny, and showed an agreeable contrast to the wintry conditions that prevailed during the latter part of the preceding month. In western districts and the extreme north during the first few days broken and rather cold conditions were general and spring growth was retarded. Thereafter, however, the weather was exceptionally dry and bright and, throughout the whole country, the conditions during the second half of March could scarcely have been more suitable for good husbandry. Dry weather favoured the sowing of seed at the beginning of April, but about the middle of that month growth was checked by cold winds, and in some areas the crops suffered a certain amount of damage from frosts. During May the weather was exceptionally favourable for farmers and, while dry and bright conditions generally enabled them to make excellent progress with their seasonal work, there were in all districts sufficient showers of mild rain to stimulate the growth of crops and maintain pastures in a fresh, luxuriant condition. Towards the end of the month the young turnip crop suffered more or less from a lack of moisture.

No serious injury to the young wheat plants appears to have been caused by the wintry weather at the end of February, and at the end of March the crop was generally reported to have a satisfactory appearance. Spring sowings of wheat were completed before the beginning of April, and in most cases the braird then looked fresh and green. The crop made good average progress during April and May, and at the beginning of June the plants showed vigour and good colour ; in some fields, however, the crop appeared to be rather thin on the ground. Estimates of the acreage sown clearly indicate that in all the important wheat-growing districts the area under the crop has been substantially increased and in a few districts where, in recent years, the crop has been relatively unimportant, the acreage has been increased by as much as 50 or 100 per cent. ; it appears likely that the annual returns made on 5th June will show a total increase in the area under wheat of about 17,000 or 18,000 acres.

During March steady progress was made with preparations for spring seeding and in several counties a beginning was made with the sowing of barley, but the work was by no means general until April. At the end of that month the work had in most districts been practically completed under excellent conditions. The crop germinated satisfactorily but on stiff soils some of the crop had at the end of May been slightly affected by lack of rain. According to the estimates furnished by the Department's reporters it would appear that there will be a reduction of nearly 8000 acres on the exceedingly small area under barley in 1932, viz., 69,000 acres, as compared with 100,000 acres in 1929, 151,000 acres in 1924, and 204,000 acres in 1920.

The seeding of oats began rather early and, in most of the southern and eastern counties, considerable breadths of lea oats were sown before the end of March, while on quite a number of lowland farms the work had been completed. The rain that fell towards the end of April benefited the crop, while the sunshine and gentle showers of May had a particularly good effect upon the plants, and, at the beginning of June, the crop was distinctly better than the average for the date; the braird was thick, and its healthy, dark colour indicated vigorous growth. Fairly extensive damage was reported to have been caused by grub on some of the upland farms of Roxburgh and Selkirk, and minor attacks were reported from two or three other districts, but, speaking generally, the crop was free from insect pests. So far as can be ascertained from estimates made at the end of May the total area under oats this season may be slightly reduced.

At the beginning of June beans, where grown, were generally considered to be a promising crop. As a result of genial weather the braird had a good start, and growth had been regular and strong.

Much of the land intended for potatoes had been drilled and made ready for the crop before the end of March. In the south and east practically all the earlies had been planted, most of the seed being put into the ground under almost ideal conditions. The planting of main-crop varieties made excellent progress during April, and at the end of May the work was almost finished; much of this work also was carried out under the most favourable soil and weather conditions, and in some parts the seed was planted about a fortnight earlier than usual. Early varieties made very good progress, and at the beginning of June in South Ayr and Dumbarton some of the crop was quickly approaching maturity, while in East Lothian lifting had begun. Later varieties showed rapid growth, and the shaws generally had then appeared above the ground. Estimates of the acreage planted indicate that the total area under the crop will be slightly larger than last year, but it is unlikely that the increase will exceed 2000 acres.

The preparation of the land for root crops was facilitated by the rather dry weather during May, and in many cases a particularly fine mould was easily obtainable, while farmers generally had opportunities for a very thorough cleaning of their fields. The sowing of turnips and swedes went forward with little or no hindrance, and at the beginning of June about three-quarters of the work had been completed in very fair order. On the lighter type of soils, and where the seed was sown rather late, the crop was unusually slow to braird, and on most farms growth was only moderately good. Comparatively little damage, however, was caused by frost, turnip fly, or other insect pests. The few reports received on sugar beet indicate that the crop was through the ground at the end of May and was growing quite well. Fairly considerable increases in the acreage under the crop are expected this year in some parts of Perth and Fife, while a small increase is anticipated in Angus.

Some of the earlier blossom on the fruit trees was slightly nipped by night frosts, but fortunately berry blossom was not early this year, and bush fruit suffered very little damage in this way. The prospects both for tree fruits and for small fruit at the end of May appeared to be favourable.

Sheep stocks lost condition during the snowstorms that occurred towards the end of February, but there was a striking improvement in the general appearance of the flocks during the next three months. The lambing season was a good one with a crop of lambs fully up to the average and fewer casualties than usual. The weather conditions were entirely favourable, and as a consequence of the fresh, rich growth of grass the ewes had plenty of milk and the lambs throve well. In Berwick a number of lambs aged up to ten days died from an unidentified disease, and in three districts, Kinross, Roxburgh and Selkirk, the mortality among ewes was reported to be rather heavy, but otherwise flockmasters appear to have experienced little trouble.

At the beginning of June experienced female dairy workers were short of requirements in Dumbarton, Renfrew, North Ayr and Dumfries, while male casual workers were rather scarce in South Ayr. Elsewhere the supply of farm workers was adequate, and in most districts a number of men was unable to secure engagements.

SCIENCE AND PRACTICE

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS

Spontaneous Combustion in Weed Plants Sprayed with a Solution of Atlacide (*Calcium chlorate*). *D. C. Tingey, Utah Experiment Station, Logan, Utah. Jour. Amer. Soc. Agron., Volume 25, No. 4, April* 1933.—In recent years chlorates have been used in weed control, and so far they have been used with little difficulty. One fire, however, was recorded in 1932, and it was considered to be a case of spontaneous combustion. Solution of atlacide was applied at the rate of one gallon to the square rod. The chemical was applied between 10 and 11 a.m. and a fire started on one of the plots shortly after 12.30 p.m., and a little later on other two plots. It was thought that as there was a sudden change of temperature and humidity just prior to the commencement of the fire that this might be a contributing factor. Whether or not this sudden change in temperature and humidity was an important factor in causing the fire, or whether it was coincident is not definitely known, but the importance of caution when spraying weeds with this chemical is emphasised.

Studies of Lignin in Wheat Straw with reference to Lodging. *Max Phillips, Jehiel Davidson and H. D. Weihe. Jour. Agric. Research, Volume 43, No. 7.*—Because there appeared to be no general agreement among investigators as to the probable cause or causes of lodging, the authors undertook an investigation of the problem, having in mind particularly the significance of the lignin content of the stalks as a contributory cause. The experiments described in this paper were conducted on wheat grown during the summers of 1929 and 1930.

One plot received no fertiliser treatment and served as a control; the other received sodium nitrate early in the spring at the rate of 600 lb. per acre.

A comparison of the data on lignin content showed that in every case there was a higher percentage of lignin in the lodged stalks from the fertilised plot than in the unlodged stalks from the control.

With the exception of plants in the very last stages of growth, the percentage of cellulose in the lodged plant material from the fertilised plot was higher than that from

the control plot. These data indicated that the higher percentage of lignin in the lodged plant material from the fertilised plot was not accompanied by a lower percentage of cellulose. These results were in distinct opposition to the generally accepted view of Sachs and Welton that lodging is caused by a deficiency of lignin.

The lignin content of the straw from the fertilised plot was in every case greater than that from the control plot. The straw from the plots that received the earlier application of sodium nitrate had a higher lignin content than the straw from plots receiving the later application. The straw from the plots that received sodium nitrate at the rate of 600 lb. per acre was higher in lignin than the straw from the plots that received the nitrate at the lower rate of 300 lb. per acre.

The fact that sodium nitrate, which frequently causes lodging, increased the lignin content of the straw was regarded as indicating that if lignin is to be considered a factor, a high lignin content and not a low one is responsible for lodging. This conclusion was in accord with the recent work of Dadswell and Hawley, who found that brash specimens of Douglas fir had a higher lignin content than tough specimens. The relatively higher lignin content apparently made the straw (or wood) brittle.

Sodium nitrate caused a distinct decrease in the silica content of the straw.

The results on the silica content of the straw seemed to furnish new evidence in support of the original view of Liebig, who maintained that lodging was caused by a deficiency of silica in the straw.

Nutritive Value of Pasture: IX. The Influence of the Intensity of Grazing on the Yield, Composition and Nutritive Value of Pasture Herbage. *H. E. Woodman, M.A., Ph.D., D.Sc., and D. B. Norman, B.A. Jour. Agric. Sci., Volume* 20, *Part* 4, *October* 1932.—An account is given of the final stage of the series of investigations which have been carried out with the object of determining the influence of the system of cutting (or close-grazing) on the yield, composition and nutritive value of pasturage. The following are among the conclusions reached:—

The lengthening of the interval between successive cuts from a month to five weeks leads to a definite, though not very serious, reduction in the digestibility of the herbage. This reduction is most noticeable during the flush period of growth, and the constituent most affected is the crude protein.

Under a system of 5-weekly cuts the herbage during the April fore-flush period has the protein-concentrated nature characteristic of herbage mown at shorter intervals. Its dry-matter contains 68·6 per cent. of starch equivalent, including 18·8 per cent. of digestible protein, and has the narrow nutritive ratio of 3·05.

Although 5-weekly mown grass is during May and June distinctly poorer in digestible protein than herbage obtained under systems of more frequent cutting, it is nevertheless easily capable of satisfying the needs of fattening stock for this constituent, and supplementary food is best supplied to such animals in the form of carbohydrate feeding stuffs rather than oil cakes.

During July, under a 5-weekly cutting system, the herbage becomes slightly richer again in digestive protein, and a full ration of such herbage supplies enough starch equivalent and digestible protein for 5 gallons of milk.

During August and September the digestible protein content of the grass increases still further. A ration containing 30 lb. of dry-matter at this stage supplies sufficient starch equivalent for 5 gallons of milk and enough digestible protein for 6 gallons.

The 5-weekly mown herbage, even in the periods of lowest mineral content, contained ample supplies of lime and phosphate to meet the requirements of dairy cattle.

SOILS

Modern Fertiliser Problems. *L. Schmitt. Die Ernährung der Pflanze*, 1933, *29*, 81-87, —It is frequently asserted that the use of modern artificial fertilisers has a harmful effect on the quality of the crop from the point of view of human consumption, and also tends to lessen the resistance of the plants to disease. The author shows that these assertions are unfounded, for eminent medical authorities have been unable to find any quality deterioration in the crops, and in addition experiments have shown that the application of fertilisers actually increases their resistance to disease.

The Effect of Manuring on the Resistance of Cereals to Rust. *W. Acker and F. König. Die Ernährung der Pflanze*, 1933, *29*, 101-107.—The effects of artificial manuring on the incidence of rust were observed in winter wheat treated in six different ways, viz. (1) No manure, (2) P.K., (3) N.K., (4) N.P., (5) N.P.½K., and (6) N.P.K. The severity of the rust attack, arranged in descending order, was as follows: No manure, N.P., N.P.½K., P.K., N.P.K., and N.K. The plots receiving potash showed least infection and at the same time yielded the biggest crops.

The Effect of Kainit as a Weed-Killer Five Years after its Application. *Struber. Die Ernährung der Pflanze*, **1933**, *29*, 105-107.—Kainit was applied to oats in 1927 at the rate of 9½ cwt. per acre to eradicate charlock. The experiment was successful. The field was then cropped in clover, wheat, and twice in rye, after which it was again put down in oats. It was observed that while most of the field was badly overrun by charlock, the parts treated in 1927 were almost free from the weed.

The Effect of Ground Kainit as a Weed-Killer in Oats. *M. Kling and W. Jürgens. Die Ernährung der Pflanze*, 1933, *29*, 145-147.—Ground kainit applied at the rate of 8 cwt. per acre almost completely destroyed the weeds in a crop of oats and at the same time substantially increased the yield. The weeds destroyed were charlock, tare, goosegrass, day-nettle, bindweed, corn gromwell.

Influence of Rye and Oat Straws upon the Growth and Yield of certain Vegetables. *Gilbert and Pember. Soil Science*, 1933, 35, 2, 115.—In order to test their value as substitutes for stable manure, rye straw in various stages of decomposition and well decomposed oat straw were used as sources of organic matter in a series of pot experiments with vegetables (lettuce, celery, beets, carrots, onions and spinach). Support is given to the view that large quantities of poorly decayed organic matter have an inhibitory effect on plant growth. It appears that these resistant organic matter sources have doubtful value as substitutes for stable manure, especially where the nitrogen content of the straw is very low.

The Nature of Phosphate Fixation in Soils. *M. C. Ford. Jour. Amer. Soc. Agron.*, 1933, 25, 2, 134.—This investigation was undertaken in an effort to explain some of the differences encountered in the responses of soils to phosphate fertilisation. The phosphorus fixed by soils as calcium or magnesium phosphates is readily soluble and thus quite available to plants. Phosphates of iron and aluminium are of intermediate solubility; their solubility depends on the soil reaction and is greatest in neutral soils. An account is given of the relative powers of various minerals to fix phosphorus.

Easily Soluble Nitrogen and Yield Increases. *Ostermayer. Zentralblatt f.d. Oesterreich Landw. Wien.*, 1932, *No.* 34.—Nitrochalk was applied as a top-dressing to each of the following crops: sugar beet, potatoes, rye and oats. A favourable response was obtained in all except the dry regions. For application alongside a basal treatment of 3¼ cwt. phosphoric acid and 1½ cwt. potash salts per acre, the most suitable dressing of nitrochalk was 1½ cwt. per acre.

Modern Views on Soil Management and Cultivation. *Opitz. Mittlg. d. D.L.G.*, 1932, 47, 683.—Reference is made to the importance of the weather, the effects produced by covering the surface of the ground with straw, potato shaws, etc. Intensive working of the soil increases the pore space and water content of heavy and medium heavy soils, but has the opposite effect in light sands. In the latter, rolling is particularly beneficial and increases the water content. Stress is laid on the observation that acidity develops when cultivation is neglected.

Sand and Water Culture Experiments on the Effect of Boron on the Germination and Early Growth of some Agricultural Plants. *Scharrer and Schropp. Zeit. f. Pf. Dung. u. Bodenkunde*, 1933, 28, 313.—Sand culture experiments were conducted in order to find the effect of different quantities of boron on oats, rye, barley, wheat and mustard. When boron was added in the form of boric acid it was found that barley was the most, and rye the least sensitive, but with boron added as borax, barley could tolerate considerably larger quantities than the other cereals. Water culture experiments with maize and potatoes showed that boron had a stimulating effect in very dilute solutions (up to 0·1 millegrams per litre), but in greater concentrations it had a toxic effect.

Nitrogen Accumulation in Soil as Influenced by the Cropping System. *Lyon and Bizzell. Jour. Amer. Soc. Agron.*, 1933, 25, 266.—A description is given of experiments which were conducted over a period of ten years for the purpose of determining the apparent fixation of nitrogen in soils which were liberally supplied with lime, phosphates and potash, but which received no nitrogen in artificial form. Various cropping systems were followed (lucerne, timothy, red clover, peas, vetches, wheat, oats and rye in various rotations). More nitrogen was found under legumes than in the soil growing non-legumes. Both lucerne and red clover were more effective than the annual legumes in depositing nitrogen in the soil. Total nitrogen accretion, which was found by adding to the quantity of nitrogen in the crops, the gain (or subtracting the loss) of nitrogen by the soil was greater with lucerne than with red clover, and much greater with red clover than with peas and vetches.

The Action of Sulphate of Ammonia in the Soil. *Engel and Kaufmann. Zeit. Pf. Dung. u. Bodenk*, 1933, 29, 1/3, 16.—An account is given of pot experiments carried out in order to find how much lime was required to counteract the acidity arising from applications of sulphate of ammonia on a light sandy soil, poor in organic matter (*a*) when uncropped and (*b*) when under crop. Nitrification is discussed in connection with soil acidity, and is shown to play only a minor part. The observation is made that the ammoniacal nitrogen was taken up by plants more quickly than it was nitrified. In a comparison of sulphate of ammonia and urea it is shown that the latter produces no appreciable acidity, but in order to counteract the acidity produced by sulphate of ammonia, lime is required in amount approximately twice the theoretical quantity required for the neutralisation of the sulphuric acid which could be developed. More acidity develops from the application of sulphate of ammonia on uncropped than on cropped soil.

DAIRYING

Slow Development of Acidity in Cheese Manufacture. *Whitehead and Riddel. N.Z. Jour. Agric., 46,* 225-229.—Cheese milk in which the development of acidity is extremely slow is known to New Zealand cheese-makers as "non-acid" milk. From a typical example of such a milk, the authors isolated an organism of the streptococcus type, indistinguishable in appearance from a lactic streptococcus, which produced some inhibiting substance restraining acid production in milk. The authors find that this inhibitory substance is not destroyed when the non-acid milk is heated to boiling point for thirty minutes. The source of infection of the causal organism was not determined, and it is concluded that the only practicable means of preventing the appearance in milk once infected is to cool the milk to such a low temperature that the growth of the organism will not take place.

Separation of Serum from Bottled Cream. *Trout and M'Can. Jour. Agric. Research, 45,* 483-500.—A serum layer is sometimes observed in many samples of cream which have been heat-treated but not homogenised. While the formation of such a layer of serum may be prevented by some additives, such agents should be considered as adulterations. The formation of a serum layer may be reduced to a minimum by pasteurising the raw milk to 160° F. for 15 minutes and separating at 120° F. The length of time the cream is held in cold store subsequent to bottling is an important factor in the formation of the serum layer.

Studies in Soft-Curd Milk.—*Johnson and M'Collum. Jour. Dairy Science, 16,* 225-247.—It is known that milk which produces a soft curd when acted on by pepsin, the coagulating and digestive enzyme of the stomach, is better adapted for infant feeding than a hard-curd milk. It has also been shown that the milk of individual cows kept under the same environmental conditions varies considerably in curd tension, and that the relative softness of the curd produced by the milk of any cow is an individual characteristic. The authors of this article have shown that a high casein content is associated with hard-curd milk, and a low concentration with soft-curd milk. A higher concentration of calcium and phosphorus is found in hard-curd milk. Further the concentration and manner of dispersion of the fat are important in influencing the curd character.

ANIMAL BREEDING

Cattle

Breeding Results in a Herd of Cattle Infected with Contagious Abortion. *W. W. Yapp and A. F. Kuhlman. Proc. Amer. Soc. An. Prod.,* 1932.—Working with the dairy herd of the University of Illinois, numbering some 230 head of pure-bred cattle of five different breeds, the writers state that calves born to cows reacting to the Contagious Abortion test, when fed milk from non-reacting cows, become negative and remain so throughout life unless re-infected. Under favourable conditions it requires more services to produce the same number of calves in a herd of reactors than in a herd which is absolutely clear of Contagious Abortion. Similarly, in a reacting herd the interval between calving is longer by approximately one month than in herds which are clear of the disease. The annual production in a clean herd is on the average 17 per cent. greater than that in a reacting herd. Cows with a bad breeding history continue so and are of doubtful value in the herd. In effect, the invasion of the Bang organism in a healthy cow immediately affects her breeding efficiency.

On the Evaluation of Dairy Sires. *Sewall Wright.* 1932. *Amer. Soc. An. Prod.*—Within the last two years there has been a tremendous outflow of papers dealing with the progeny test in cattle and the evaluation of dairy bulls. Many of these contributions do little more than repeat the views of previous workers. Dr Sewall Wright has brought to this problem a long experience in the practical aspects of the breeding of animals, and with this is combined a sound knowledge of biometry. He performs a service by pointing out that there are several quite different questions which one may ask, all of which relate to the same sire. The first question relates to the record to be expected from a given mating when the records of tested daughters (or other relatives) of the sire are available and also the record of the dam. This is a practical question, but clearly the answer is not an evaluation of the sire. It is an evaluation of a mating.

The second question deals with the expectation of the yields of future daughters of a bull, knowing his past performance, and assuming that he continues to be used in the same herd or in one of similar genetic constitution. The answer to this again is not an evaluation of the sire, it is an evaluation of the sire plus the dams on a certain level of production.

The third question deals with the record that would be expected of daughters of a bull if the latter were mated with a random sample of cows of the breed. The answer to this question is the only one that could properly be used as the basis for an evaluation of the sire. This is sound logic and explains the discrepancies and the arguments which are at present to be found amongst those who are talking about this subject.

Dr Wright lays it down that, since in practice different bulls have different opportunities in that they are mated to cows of different genetic constitution giving different yields of milk, and that since any attempt to obtain an unbiased evaluation demands that all of the sires to be compared be mated to comparable groups of cows, then it is clear that the proper formula must take these facts into account and must discount in some way the records of tested daughters by some measure of the differing genetic potentialities of their dams. This again is sound logic. Dr Wright then goes on to discuss two of the existing formulae which approximate these conditions, and this leads him to the production of a third which, since it is of a mathematical nature, cannot be easily applied in practice although all that it does is merely to show mathematically methods which would be appreciated by any non-mathematical breeder.

For the proper assessment of the hereditary constitution of a bull, this paper shows how important it is to take into consideration the yields of the dams of the daughters as well as the yields of the daughters of the bull himself.

The Inheritance of Milk Production and Butter-fat Percentage in a Herd of Pure-bred Ayrshire Cattle. *Edwin E. Heizer. Proc. Amer. Soc. An. Prod.*, 1932.—This study was made on records of the well-known Penshurst Farm near Philadelphia where Mr Percival Roberts, the owner, placed the data at the disposal of the author of this paper. The Penshurst Ayrshire herd was founded in 1906 by an importation from Canada. This was subsequently augmented by several importations direct from Scotland. With the exception of the early purchases very few outside individuals have been introduced, and as a result of constructive line-breeding the herd is composed of a very uniform group of cattle. All cows have been tested so long as they were in the herd, which has been under the same management for approximately twenty years.

The first part of this study was designed to test the transmitting ability of the various sires used in the herd, practically all of which were bred on the farm. Considerable differences appear to exist amongst the different bulls as regards their ability to transmit the factors for milk production. An example of two bulls is given: both were used in the herd at the same time and many of the cows produced daughters by each sire. The one bull increased the production of 135 daughters as compared to their dams by approximately 130 gallons of milk per cow, while the other sire lowered the milk production by an almost similar amount.

The author correlated the yields of the daughters with the yields of their dams and obtained a correlation of 0·507, which is in close agreement with other work dealing with this subject. In fact, this means that the dam contributes 50 per cent. of the inheritance towards her progeny. This is additional evidence which puts aside the contentions of some other workers that the dam makes only a small contribution as regards hereditary characters to the daughter. Such statements are, however, without adequate statistical support.

There are some further data on the inheritance of butter-fat percentage.

The Vitamin A Activity of Butter Produced by Guernsey and Ayrshire Cows. *J. W. Wilbur, J. H. Hilton and S. M. Hauge.* 1933. *Jour. Dairy Science, Volume* 16, 153-156.—This paper deals not with the vitamin A activity of milk but of butter. Colour of butter, which is known to vary with the different breeds of cows, is due almost entirely to carotin. Since carotin is now recognised as a precursor to vitamin A, it might seem logical to assume that butter rich in this pigment might also possess greater vitamin A activity than a paler-coloured butter, and thus it might be assumed that the Channel Island breeds were possessed of a greater vitamin A content than that of other dairy breeds. Butter, however, does not owe its entire vitamin A activity to carotin. Thus this investigation conducted by these workers at the Agricultural Experiment Station at Indiana is of particular interest.

According to one worker, Jersey cows give a yellow colour-value of twice that obtained with butter produced by Shorthorn cows under similar nutritive conditions. For the purpose of this experiment two Ayrshire and four Guernsey cows were used. All six were fed alike from the beginning of their lactation period. In addition to pasture they received balanced grain rations, and during July and August were fed small amounts of alfalfa hay and silage. Later on, their ration consisted of maize, ground maize, ground oats and linseed cake. Samples of butter were taken and subjected to biological assays to determine the vitamin A activity by feeding to rats. The results indicate that the vitamin A activity of the butters from the two breeds showed no appreciable variation. This result was rather surprising in view of the disparity between the colour of the butters. Such a result might at first appear to be in agreement with a previous investigation by Davis and Hathaway, who concluded that there was no difference in the vitamin A content of milk produced by different breeds of cows under similar feeding conditions. The authors point out that Davis and Hathaway were working with whole milk of variable fat content, while with this experiment the tests were made on butter. Since the vitamin A potency of milk resides in its butter-fat, it is possible to translate the results of the tests of Davis and Hathaway with milk into a comparable vitamin A value for the butter-fat. The authors discuss the point, and in conclusion state that it is apparent that, under similar feeding conditions, the higher the percentage of butter-fat in milk the greater will be its activity in regard to vitamin A.

Value of a Brahman Cross on Native and Grade Beef Cattle in Southern Louisiana. 1933. *Amer. Soc. An. Prod.*—This paper deals principally with the growth of different types of cattle in Louisiana, including crosses with the Brahman (Zebu). The writers state that the Brahman is pre-eminently a grazing animal and makes good gains on coarse grasses. The Brahmans do not appear to suffer to the same extent from flies, mosquitoes and external and internal parasites. They also stand the heat better. Further, at the Louisiana Station no Brahman grades have died from bloating on clover, while losses amongst the breeds of British origin are sometimes severe. The authors state that the principal advantage of the Brahman lies in its capacity for making gains on grass alone, a quality that is of great importance on the coastal plains. There follow notes on the selection and breeding of these animals.

A Comparison of Body Measurements of Beef and Dual-purpose Cattle. *Bradford Knapp, Jr., and A. C. Cook.* 1933. *Proc. Amer. Soc. An. Prod.*, 77-84.—This paper deals with a comparison of beef and dual-purpose cattle as regards their body measurements. The bulk of the data is confined to the first 448 days of age, since both beef and dual-purpose types by that time reach the required 900 lb. weight established as the slaughter weight for the record of performance test. The growth data are divided into three groups with reference to meat production as follows: (1) increase in weight; (2) increase in skeletal structure, *i.e.* the framework upon which the meat is laid; (3) increase in volume of flesh due to fattening as well as to growth. This report deals with these last two points and their relation to the first.

The writers selected height at withers, length of body, depth of chest, and height of floor of chest as measures of skeletal growth. Up to 196 days of age height at withers was practically equal, but at that point the difference between the two groups became significant and so remained during the rest of the period studied. The dual-purpose calves were taller, and if the curves had been carried out to maturity they would show that the dual-purpose cattle remain taller than the beef cattle. As regards earlier life, the beef calves showed a greater body length than the dual-purpose ones, which is not balanced till the animals reach one year of age. At 448 days the difference is not significant. At slaughter the dual-purpose steers are not only taller but longer bodied. The writers found considerable difference between the two types in the length of leg. It was the only measurement that showed a significant difference at birth and so remained during the entire period. At 15 months the dual-purpose calves were deeper bodied than the beef calves. For the skeletal measurements as a whole, the differences in early life are similar, but the dual-purpose calves are faster growing, and on the whole are larger than the beef-type calves. To indicate the changes in the amount of meat and fat deposited upon the skeletal structure, measurements were made of the heart growth and width of body and also width of chest and width at shoulder. In all the flesh measurements the beef calves showed a superiority throughout the period studied. Width of chest and shoulder, for instance, are practically equal at birth, but these measurements become significantly different in the two types at an early age and continue so throughout the period.

The writers conclude that in the Beef Shorthorn the breeders have selected and bred chiefly for more meat. Dairy breeders have selected primarily for milk production. In the dual-purpose types an intermediate was sought that would produce both meat and milk with reasonable efficiency. It is claimed that the data in this paper emphasise the success of breeders in moulding their respective breeds for the function they wish them to have.

Horses

The "Pied" and "Splashed White" Patterns in Horses and Ponies. *V. Klemola.* 1933. *Jour. Hered., Volume* 24, *No.* 2, 65-69.—The piebald or skewbald pattern of horses behaves as a simple dominant. That is to say that a piebald horse can be obtained only when at least one of its parents is also piebald. Wall eye is rarely associated with the piebald character, and however little colour may be shown on a piebald animal, some colour is always to be found upon its head.

In the character to which the present writer refers the pattern factor is very nearly the reverse to that of piebald, since it is the head which lacks colour. This marking has been termed "Splashed White" and is associated with Wall eye. This "Splashed White" is inherited in a recessive manner.

Sheep

The Effect of Early Breeding on Ewes. *D. J. Griswold.* 1933. *Amer. Soc. An. Prod.*, 181-183.—At the beginning of 1927, 244 range-raised Hampshire-Rambouillet ewe lambs that averaged 74 lb. were delivered at the North Dakota Experiment Station at Fargo. Half of these—122 lambs—were placed in breeding pens to produce lambs in May 1928, the other group was kept open till late in 1928, when both groups were bred to produce lambs in May 1929. Since then both groups have been bred each autumn for May lambs. Except when it was necessary to separate them for the first breeding and lambing season, the ewes have run together the whole time. They were fed liberally enough to produce good growth and development, but no attempt was made to force them. In September 1927 they weighed 74 lb. Of the 122 lambs in the breeding pens in 1927 104 conceived and produced 105 lambs in 1928. This was a production of 86 per cent. on the basis of ewes in the breeding pens. The young mothers had a good supply of milk, but many lambs were weak and had to be hand fed. In spite of the best care that could be given, the mortality was high. Only 78 lambs survived to October 3rd, when they were weaned at an average weight of 68 lb.

The following May (1929) both groups produced lambs. Amongst the first group which had already given birth to a crop of lambs, the average weight of their lambs at weaning was 1 lb. greater than the other group which had never previously given birth to lambs. In 1930 the average weight of the lambs at weaning was 1 lb. greater for the yearling-bred group in 1929 ; 3 lb. greater in 1930 ; 2 lb. greater in 1931, and 5 lb. greater in 1932. The percentage of fat lambs at weaning also has been consistently in favour of the yearling-bred group. The figures are 68 to 62 in 1929 ; 64 to 58 in 1930 ; 46 to 45 in 1931, and 18 to 10 in 1932.

It is yet too early to know whether these lamb-bred ewes will outlive their usefulness sooner than those not bred until one year older. At the present time, when the ewes are five and a half years old, no definite indication that such will be the case has been observed. So far the mortality from all causes has been the same, 23 per cent. for each group. It is not the purpose of this paper to recommend the breeding of ewe lambs, but only to present briefly some of the more important results so far obtained.

Inbreeding and the Genetic History of the Rambouillet Sheep in America. *W. F. Dickinson and Jay L. Lush.* 1933. *Jour. Hered., Volume* 24, *No.* 1, 19-33.—This paper opens with a most interesting account of the history of this breed. In the latter part of the eighteenth century Spain had a monopoly in the production of fine wool. Fearing that Spain would increase her factories and prohibit the exportation of wool, as she had already prohibited the exportation of Merino sheep, the rulers of France sought to improve the French sheep so that France would be independent of Spain for its supply of fine wool. Accordingly, Louis XVI asked the King of Spain for a grant of Spanish Merinos for the experimental farm he had recently established at Rambouillet near Paris. In 1786 this request was granted and there were brought to Rambouillet 318 ewes and 41 rams, while a second importation was made from Spain to France in 1801. No new blood has been added to the flock at Rambouillet since 1801, and records have been kept without interruption since 1786. Rams from Rambouillet were used upon Merinos driven into France during the rule of Napoleon. Some of these Spanish Merinos were taken to Germany, the most notable breeder being Von Homeyer, who was at the height of his fame about 1860. Nearly half of the ancestral lines of the pedigrees of the American Rambouillet end in foundation animals which were bred in the Von Homeyer flock, and a few more lines end in foundation animals from other German flocks. The first importation to the United States was in 1840, and in 1880 Von Homeyer sent a ram and two ewes as a gift to a breeder in New York. He exhibited his sheep at the World's Fair in Chicago exactly forty years ago. In all, some seventy sheep were brought to the States from this herd in Germany.

Up to date some 280,000 Rambouillet sheep have been registered, and the writers have taken random samples from the animals registered in ten-yearly periods from 1896 to 1926. Wright's Coefficient of Inbreeding, which measures the degree of likeness between the parents of an individual, has been used in this study. The Inbreeding Coefficient for the American Rambouillet breed of sheep rose from 2·2 per cent. in 1896 to 5·5 per cent. in 1926. In 1891 the relationship of any two animals taken at random from the breed was nearly as close as that between animals having one grandparent in common and no other relationship. After 1896 there was a sharp decline in average relationship. Presumably the importations of the following decade were not equally distributed among the different breeders. Since 1906 there has been a slight rise in the average *inter se* relationship. No one ancestor has ever had a very dominant influence on the breed. The average interval from generation to generation is 4·2 years. Most of the ancestral lines end in animals born in the few years immediately preceding 1894.

The writer discusses how improvement of the breed could take place more rapidly than at present. He suggests that flocks above the breed average in merit should be grouped so that each group would contain three to five rams of breeding age and many ewes. Animals originating in flocks outside the group would be introduced very reluctantly. Within each such group breeding stock would be interchanged freely with little attention to pedigree (except to avoid too close inbreeding), but with as much attention as possible to individuality and to the merit of the progeny. Such partial isolation would soon result in each such group becoming very uniform but perhaps distinctly different from a neighbouring group which might have started out with much the same kind of foundation stock. The principles of such a system are essentially those which have been used irregularly in the development of the pure breeds.

Pigs

Pig Recording as a Factor for Cheapening and Increasing Pig Production. *H. R. Davidson.* 1933. *Jour. Min. of Agric., Volume* 40, 42-50.—The author reviews the question of an increase in pig production, Danish over-production, and discusses the question of cost of bacon production in this country. He deals with the factors affecting the cheapening of pig production, and the latter part of the paper deals with the relative merits of litter testing and pig recording.

Swine Production in Alberta. *R. D. Sinclair. Department of Animal Husbandry, University of Alberta,* 1932, *Bulletin No.* 22.—Amongst other things the writers of this bulletin deal with the question of outlet for the surplus production of pigs in the Dominion of Canada. They reach the conclusion that the British market is the one which Canadian pig producers must cultivate. The writer is of the opinion that, apart from proximity to Britain, Denmark has no particular natural advantages over Canada in the matter of bacon production, while with regard to feed supply, apart from dairy by-products and climate, Canada has the upper hand. He then deals with the Wiltshire side and the type of bacon pig required to produce it.

The Dominion Government Hog Grading Policy came into effect in 1922, with the object of grading, by an official Government grader, of all pigs offered for sale at Canadian stockyards, and the payment of a premium for pigs of the type and quality suitable for the production of the highest grade of export bacon. A table is set out showing the percentage of the different grades from the Provinces of Alberta and Ontario respectively, as well as from Canada. Approximately 15 per cent. of the pigs marketed in Canada in 1931 reached the top grade of selected bacon, and about 50 per cent. reached the two top grades. Roughly, only half of the pigs reached the standard of quality to process into an article of anything like export standard. In the Province of Ontario, where the bacon type of pig has been established for a good many years, the type produced is more in accord with market requirements, whereas in Alberta only 7 per cent. reached the top grade. On the whole, the pigs in Alberta were generally too short and thick and over-finished to dress into Wiltshire sides of the proper quality. The writer discusses the Dominion Government Policy of Advanced Registry in Swine. This scheme seeks to identify the best producing sows and boars in pure-bred herds and puts a premium on litter size, early maturity and carcase quality. Thus the breeder owning sows and boars qualifying under this scheme is in a position to supply superior breeding stock.

There are also some interesting pages on the feeding and general management of pigs in Alberta.

Production Tests for the Selection of Breeding Hogs. *E. F. Ferrin. Proc. Amer. Soc. An. Prod.,* 1932.—Several countries have developed plans for testing swine, basing economy of live-weight gain on feed consumption and carcase data. These, together with records of prolificacy and type, furnish the basis for selection of breeding stock. In Denmark a register of merit is published giving the information needed by breeders who desire to purchase stock from tested herds. The Record of Performance system in operation in the United States since 1927 has many points of similarity with the Danish plan, and the present paper deals with the practical outcome of some of this work.

Early maturity seems to be a very necessary characteristic if a sufficient finish is to be obtained at the market weight of 225 lb. Long-bodied pigs are usually late-maturing especially if they lack depth of body, but late maturity is not necessarily correlated with size. Measurements of live pigs show that depth and width of body are pronounced in quick-maturing pigs. The writer recommends breeders to discriminate against the leggy, late-maturing type of swine, and states that it is not necessary to advise the production of a pig small in size in order to obtain early maturity.

In view of the fact that this record of performance deals with only a small percentage of the pig population, the writer suggests that if a means could be provided whereby the farmer could select the stock in his own herd it would extend the possibilities of improvement in economy of production to all pork raisers. Such a plan has been worked out by the National Swine Record of Performance Committee of America. In Minnesota the plan is termed "The Minnesota Sow Testing Project." The object is to select breeding sows from litters of pigs from heaviest weight at 56 days of age. Weights at weaning-time measure the pork-producing ability of sows just as accurately as weights of litters when marketed. It is recommended that each pig be weighed separately at weaning time, but litter weights will be accepted if the total number and sex of the pigs of each litter are reported. This system demands the active co-operation of county agents, and the writer strongly advises a slaughter test on at least two of the pigs of each litter to be made when they reach 200-225 lb. each. In effect, the procedure outlined by Professor Ferrin is much the same as that which we had employed in this country under the title of pig recording.

Poultry

Spurlessness of the White Leghorn. *A. W. Kozelka.* 1933. *Jour. Hered.*, *Volume* 24, *No.* 2, 71-78.—Three spurless chicks hatched among a number of normal spurred individuals from a strain of white Leghorns which exhibited considerable variation ranging from total absence to spurs that were approximately the size of a male spur. The spurless condition is apparently due to the absence of the integumental portion normally found in the ordinary spur. At time of hatching both sexes are spurless or, at most, show a slight vestige of a spur, but after sexual maturity sex dimorphism appears in the form of a bony outgrowth from the shank bone in the region of the spur of the male; in the female no such growth takes place. Genetic evidence indicates that the spurless condition is inherited as a Mendelian recessive, with only a single factor difference between the spurless and the normal.

The spurless condition is apparently associated with a reduction of vitality. A significantly smaller proportion of the spurless segregates survived than the spurred.

General

Prepotency of Inbred Sires on Commercial Varieties of Maize. *E. W. Lindstrom.* 1931. *Jour. Amer. Soc. of Agron.*, *Volume* 23, 652-661.—Properly speaking, this paper deals with the breeding of maize. However, there is a point in it which is of possibly fundamental importance in the question of the improvement of live stock.

While experimenting with a practical method of line-breeding in corn, the writer had occasion to pollinate commercial corn with some of his strains which had been inbred for six generations. He was at once struck with the surprising prepotency of some of these inbred lines, particularly in the matter of plant uniformity, ear type, ear height, disease resistance, lodging and yield. It was especially noted that such crosses, where the sire was inbred, possessed a much lower percentage of poor or barren stalks than was the case in commecrial varieties. If a second dose of the same inbred sire was used on these progenies, there was a quick return to the poorer vigour of that inbred strain. In other words, a single dose of certain inbred sires on a commercial variety proved to be optimum for practical purposes. Accordingly a series of tests was inaugurated with the expectation of determining the relative prepotency of inbred lines from the practical standpoint. The experimental results have demonstrated that significantly increased yields of grain are possible by this means and that there was definitely established a marked prepotency for the qualities mentioned above. The simplicity of the practical phases in the production of seed renders this inbred-sire breeding system practicable for the average progressive breeder of maize.

It would seem highly probable that this simple top-cross system of breeding would be the ultimate method used in the economic production of live stock. As a matter of fact, this is already the system which is most largely in vogue, with this difference, that the sires used are not as a rule intensively inbred. However, full application of this method is out of the question in the immediate future, since there is the fundamental difficulty of obtaining many good inbred strains of animals, even in poultry and swine. Accordingly, it would seem as though the present custom of the use of inbred sires on standard breeds affords the best solution for the progressive breeder.

ANIMAL NUTRITION

A Study of the Effects of Alfalfa Hay and Irrigated Pasture on Growth of Holstein Heifers. *H. S. Willard. Jour. Dairy Sci.*, 1932, *15*, 435-444.—Two groups of Holstein heifers were fed on alfalfa hay as the sole roughage during the winter and grazed on irrigated pasture during the summer. Group I was a control and Group II received 2 lb. ground barley per head daily during the winter months only. During the winter Group I gained 28·5 lb. per head monthly and Group II 32 lb. During the summer the monthly gains were 35·14 lb. and 44·67 lb. respectively. The data for the individuals indicate that size of heifer may still be a factor influencing rapidity of growth on roughage alone, even up to 16 months old.

Feedlot Fattening Rations for Cattle. *G. E. Morton and H. B. Osland, Colorado Exp. Stat., Press Bull. No.* 77, *Dec.* 1931.—Barley is not a suitable grain to feed as the sole grain in a grain, cotton-seed cake and hay ration, owing to risk of causing bloat. For supplementing such diet wet beet pulp, corn silage and potato cornfodder silage are suitable bulky carbonaceous supplements.

Ration Experiment with Calves. *G. E. Morton and H. B. Osland. Colorado Exp. Stat., Press Bull. No.* 78, *Sept.* 1932.—In feeding trials with a standard beet by-product ration of grain, wet beet pulp and alfalfa hay, a protein supplement of half a pound a day of cotton-seed cake is sufficient for calves. Linseed oil cake and ground flaxseed gave the same gains but at greater cost. Feeding wheat alone as the grain part of the ration was not harmful, but the calves were slower in getting up to full feed than when barley alone, or corn and barley or corn and wheat were fed as grain.

Liberal versus Limited Rations for Breeding Ewes during Winter Season. *G. W. Putnam and L. H. Blakeslee. Agric. Exp. Stat., Michigan State Coll. Agric. and Appl. Sci., Quart. Bull.*, 1932, *15*, 100-102.—Three lots of breeding ewes received 4 lb., 3 lb., and 2 lb. of legume hay respectively during wintering. The third group received 1 lb. of oat straw, and all groups received grain. It was found that while the first lot, presumably receiving the better ration, made a much larger gain during the gestation period, they lost more weight while lambing and gained less on pasture. All three lots produced an excellent crop of lambs and weighed approximately the same when their lambs were weaned, indicating that the three rations used were satisfactory in maintaining the ewes over a period of years.

The Nutritive Value of Efficiency of Mineralised' Milk. *A. R. Kemmerer, C. A. Elvehjem, E. B. Hart and J. M. Fargo. Amer. Jour. Physiol.*, 1932, *102*, 319-324.—Rats and pigs were fed from weaning on cow's milk, to every 30 c.c. of which was added: iron 0·5 mg., copper 0·05 mg. and manganese 0·04 mg.; pigs received in addition cod-liver oil. The average gain in weight was the same as in those fed on a stock ration (rats 3·9 g. and pigs 1·26 lb. per day). Only 1·97 lb. milk solids were required to produce in pigs an increase in weight of 1 lb. as compared with 3·53 lb. of the stock ration. Whole cow's milk is therefore an efficient food if its deficiencies are corrected by the addition of minerals.

Dried Sugar Beet versus Flaked Potatoes. *Dr Immler. Ztschr. f. Schweinezucht*, 1932, *39*, 716-717. (*Heilsberg.*)—Two groups of 10 pigs each were fed a basal ration of barley meal (later partially replaced by maize meal) and a protein food mixture plus 1 litre of skimmed milk per pig daily. During the first eight weeks, 1 kg. basal mixture was fed per pig per day and beetroot or chaff added *ad lib.* After this period the basal rations and milk only were fed. In addition to the above foods the ration for Group I contained 20 per cent. dried sugar beet, and the ration for Group II contained 20 or 30 per cent. potato flakes.

The results showed that the dried sugar beet was superior to the potato flakes as a pig food, the rate of growth of the pigs in Group I being greater and the food consumption and cost per kg. live weight being less than those in Group II.

The Effect of Feeding Sunflower Seed on the Quality of Bacon. *C. A. Murray. Rhodesia Agric. Jour.*, 1932, *29*, 699-707.—A pig ration in which 50 per cent. of the concentrates consisted of sunflower seed produced, without exception, very soft and oily fat, rendering it impossible to use the carcases for bacon manufacture.

Copper Poisoning in Sheep. *J. A. Beijers. Tijdschr. v. Diergeneesk*, 1932, *59*, 1317-1324.—Cases of copper poisoning are described in sheep grazing in orchards where a copper sulphate spray had been used. The symptoms were marked anæmia and jaundice with blood both in urine and fæces. Liver and kidneys showed degenerative changes, and large quantities of copper were found in liver and bile.

Green Feed Deficiency Disease in Fowl. *J. K. Hutchison. Agric. Gaz., N.S.W.*, 1932, *43*, 835-840.—" Green feed deficiency disease," known also as " avitaminosis A " or " nutritional roup," is caused by deficiency of green food in the ration of fowls. The symptoms of the disease, in the case of laying birds, are described, viz., arrested development, lowered egg production, wasting, accompanied by the appearance of white pimples in the mouth, throat, eyes and nasal cavities, and, on post mortem examination, white spots on the kidneys. It is recommended that 2·4 per cent. cod-liver oil be included in the ration, and this can be displaced in part by green food if available.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS, AND FERTILISERS IN MARCH, APRIL and MAY 1933.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets.

(*Compiled from Returns received from the Department's Market Reporters*)

Description	March			April			May		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*Cattle—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ..	48 4	43 1	38 6	47 8	42 9	40 8	46 11	41 10	40 2
Cross-bred (Shorthorn)	45 1	40 8	31 4	44 3	40 2	33 1	43 1	39 2	32 4
Galloway	42 11	40 3	..	44 6	40 2	..	42 3	39 6	..
Ayrshire	39 1	32 5	27 3	38 2	35 9	31 3	38 9	34 3	28 5
Blue Grey	..	..	..	50 3	46 3	..	51 5	44 5	40 0
Highland	..	..	..	..	..	..	..	..	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†Veal Calves	14½	3½	..	13¾	3½	..	12	3½	..
†Sheep—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.
Cheviot	10	8¼	7¼	10¾	9½	7½	10¾	9¼	7
Half-bred	9¾	8¾	6½	10¼	9	6½	10	8½	5½
Blackface	10	8½	6¾	10¼	9¼	7¼	10¾	9¾	7
Greyface	10¼	9	6½	10½	9¼	7¼	10¼	8¾	6
Down Cross	9¾	8¾	6	10¼	9½	6	10¼	9½	4¾
†Pigs—	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.
Bacon Pigs	8 9	7 10	..	8 9	7 8	..	8 4	7 5	..
Porkers	9 8	8 10	..	9 7	8 9	..	9 2	8 5	..

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK: Monthly Averages of Prices (per head) at certain representative Scottish Markets—(*continued*).

DESCRIPTION	MARCH			APRIL			MAY		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—									
Aberdeen-Angus:	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*
Yearlings	14 19	11 6	9 18	15 9	12 7	10 7	15 4	12 11	8 15
Two-year-olds ..	20 1	16 6	12 13	19 10	15 17	12 10	20 6	16 3	11 14
Cross-bred (Shorthorn)									
Yearlings	13 19	10 2	9 5	14 7	10 19	9 10	14 9	11 1	8 10
Two-year-olds ..	19 10	15 1	11 5	18 5	14 19	11 6	18 14	15 0	10 4
Galloway:									
Yearlings	13 0	10 10	..	13 13	11 9	..	13 12	10 15	..
Two-year-olds ..	16 5	14 0	..	18 7	15 18	..	21 0	16 11	..
Ayrshire:									
Yearlings	..	..	..	11 11	10 12	8 0	12 4	10 11	10 0
Two-year-olds ..	..	..	..	17 5	11 0	9 0	14 15	12 11	..
Blue Grey:									
Yearlings	..	..	..	14 15	..	..	13 10	10 10	..
Two-year-olds ..	..	..	..	22 0	..	..	20 10	..	..
Highland:									
Yearlings	..	..	..	..	..	..	9 10	8 0	6 5
Two-year-olds ..	..	..	..	..	..	..	12 0	10 10	8 10
DAIRY COWS—									
Ayrshire:									
In milk	22 12	15 19	12 0	23 8	17 7	13 0	22 4	16 9	12 6
Calvers	21 17	17 0	13 8	24 6	18 8	14 0	24 1	17 18	13 11
Shorthorn Cross:									
In milk	26 4	18 11	..	24 19	17 4	16 0	23 17	17 2	15 5
Calvers	24 8	17 3	12 18	23 16	17 15	14 9	24 1	17 15	14 9
SHEEP—	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Cheviot Hoggs ..	30 3	22 6	..	30 7	20 11	..	31 3	23 10	..
Half-bred Hoggs ..	38 2	28 0	..	41 5	29 10	..	41 9	30 0	..
Blackface Hoggs ..	23 0	16 3	12 0	23 7	18 0	15 0	29 2	21 11	16 6
Greyface Hoggs ..	34 9	26 6	24 6	35 5	27 6	22 10	35 2	27 7	..
Down Cross Hoggs	..	..	..	35 11	..	..	..	..	..
PIGS—									
(6 to 10 weeks old)	32 6	20 0	..	33 9	20 9	..	33 2	20 9	..

DEAD MEAT: Monthly Average Prices (per lb.) at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	MARCH			APRIL			MAY		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
BEEF:—										
Home-fed—		*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*
Bullock or Heifer ..	1	8	7½	9¼	7½	7⅜	9	7½	7¼	8⅝
	2	7⅜	..	8⅛	7	..	8	6⅞	..	8
Bull	1	6⅛	5⅝	6½	6	5⅜	6½	5⅞	5⅝	6½
	2	5⅜	..	6	5½	5	6	5¼	5	6
Cow	1	5¼	5¼	5½	5	4⅞	5½	5	5	5½
	2	4⅝	..	4⅝	4½	..	4½	4½	..	4½
Irish—										
Bullock or Heifer ..	1	..	..	7¾	..	..	7¾	..	..	7¼
	2	..	..	7¼	..	..	7¼	..	..	7
Argentine Frozen—										
Hind Quarters ..	1	4½	4	..	4½	3⅞	..	4⅛	4	..
	2	..	3⅝	..	..	3⅜	..	..	3¼	..
Fore ,, ..	1	4	3⅞	..	4	3⅝	..	3⅜	3½	..
	2	..	3½	..	..	3⅜	..	..	3	..
Argentine Chilled—										
Hind Quarters ..	1	6⅜	6⅛	6¼	6⅜	6⅜	5⅝	6	6¼	5⅛
	2	..	5¼	5⅝	5	5¼	5¼	..	4⅝	4⅞
Fore ,, ..	1	4½	4⅜	4	4¼	4⅛	3¾	4	4	3⅜
	2	..	3¾	3¾	4	3⅜	3½	..	3¼	3¼
Australian Frozen—										
Hind Quarters ..	1	..	..	3¾	..	..	3½	..	..	3¼
	2	..	..	..	..	..	..	..	..	..
Crops	1	..	..	3½	..	..	3¼	..	..	3
	2	..	..	..	..	..	..	..	..	..
New Zealand Frozen—										
Hind Quarters ..	1	..	..	3⅝	..	..	3½	..	..	3¼
	2	..	..	..	..	..	..	..	..	..
Fore ,, ..	1	..	..	3¼	..	..	3⅛	..	..	2⅞
	2	..	..	..	..	..	..	..	..	..
MUTTON:—										
Hoggs, Blackface ..	under 60 lb.	11	10	9¾	11	10¾	10⅞	10⅞	11½	10⅝
	60 lb. & over	10	..	9⅛	10	..	10⅛	9⅞	..	10
,, Cross ..	under 60 lb.	11	10	9¾	11	10¾	10⅞	10⅞	11½	10⅝
	60 lb. & over	10	..	9⅛	10	..	10⅛	9⅞	..	10
Ewes, Cheviot ..	1	..	7	7¾	..	7⅛	8⅜	..	6⅞	7⅞
	2	..	..	7⅜	..	..	7⅞	..	..	7⅜
,, Blackface ..	1	7⅝	7	7¾	8	7⅛	8⅝	7⅞	6⅞	7⅞
	2	7	..	7⅜	7	..	8	7¼	..	7⅜
,, Cross	1	6⅛	7	7¾	6	7⅛	8⅜	5⅞	6⅞	7⅞
	2	5¼	..	7⅜	5	..	7⅞	4⅞	..	7⅜
Argentine Frozen ..	1	..	..	3¾	..	..	3¾	..	..	3¾
	2	..	..	..	..	..	..	..	..	..
Australian ,, ..	1	..	4⅝	3¾	..	4⅜	3⅝	..	4⅛	3½
	2	..	3⅝	3½	..	3½	3½	..	3⅜	..
New Zealand ,, ..	1	..	..	3¾	..	..	4⅛	..	..	4
	2	..	..	3⅜	..	..	3⅜	..	..	3¼
LAMB:—										
Home fed—	1	..	..	10⅝	..	..	14¼	..	..	14
	2	..	..	10⅛	..	..	11⅛	..	..	11
New Zealand Frozen	1	..	6½	5½	..	6¾	6⅛	..	6⅜	5¾
	2	..	5½	..	..	5⅜	5½	..	5	5¼
Australian ,, ..	1	..	..	4⅝	..	..	5	..	..	5
	2	..	..	..	..	..	..	..	..	..
Argentine ,, ..	1	..	..	4¾	..	..	5	..	..	4¾
	2	..	..	..	..	..	..	..	..	..

EGGS: Monthly Average Wholesale Prices at Aberdeen, Glasgow and Kilmarnock.

PROVISIONS: Monthly Average Wholesale Prices (per cwt.) at Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	DESCRIPTION	QUALITY	MARCH	APRIL	MAY
			s. d.	s. d.	s. d.
ABERDEEN	Country .. .. per doz.	1	1 0	0 8	0 9½
		2	0 11	..	0 9
	Duck .. .. „	1	1 1	0 9	0 9½
		2	..	0 8	..
GLASGOW	Country .. .. per doz.	1	1 1	0 11	1 0
		2	0 11	0 10	0 11
	Irish— Northern Ireland per 120	1	10 8	8 9	9 8
		2	9 11	8 3	8 10
	„ (Duck) „	1	12 1	8 6	8 3
	„ Free State „	1	9 10	7 10	8 1
		2	9 6	7 6	7 9
	„ (Duck) „	1	11 11	7 11	7 9
	Danish .. .. „	1	8 3	..	..
	Polish .. .. „	1	..	6 4	..
KILMARNOCK	Country .. .. per doz.	1	..	0 10	0 11

DESCRIPTION	QUALITY	MARCH	APRIL	MAY
BUTTER—		s. d.	s. d.	s. d.
Irish Creamery	1	..	..	83 3
	2	..	..	77 6
„ (unsalted	1	..	..	89 6
Argentine	1	..	..	67 6
„ (unsalted)	1	..	..	71 0
Australian	1	80 5	74 3	80 0
„ (unsalted)	1	83 2	78 0	87 6
Danish	1	103 5	95 3	97 5
„ (unsalted)	1	109 5	100 9	100 7
New Zealand	1	82 2	76 6	80 0
„ (unsalted)	1	85 7	83 6	84 7
Siberian	1	90 0	..	66 0
Swedish	1	99 0	96 0	92 9
Latvian	1	86 0	80 0	81 8
CHEESE—Cheddar	1	88 10	60 0	70 0
	2	85 0	..	..
Cheddar Loaf	1	97 2	94 0	67 0
	2	84 0	..	..
Dunlop	1	70 5	61 0	59 7
	2	67 0	..	50 0
Canadian	1	74 0	73 3	74 10
New Zealand (Coloured) ..	1	55 7	54 0	53 10
„ (White)	1	51 2	48 9	52 2
HAMS—Irish (Smoked)	1	136 0	142 0	150 0
	2	122 0	125 0	138 5
American (Long Cut, Green) ..	1	70 0	77 0	86 5
„ (Short Cut)	1	71 2	77 6	86 0
Canadian (Long Cut)	1	69 2	76 0	90 0
BACON—Ayrshire (Rolled, Scotch Pork)	1	107 6	112 0	115 10
English Wiltshire (Green) ..	1	100 0	104 0	111 2
„ (Dried or Smoked) ..	1	106 0	110 6	116 10
Irish (Green)	1	..	..	105 10
„ (Dried or Smoked) ..	1	..	..	108 0
„ (Long Clear)	1	92 5	94 0	105 0
American Sides (Cumberland Cut)	1	56 0	66 0	..
Canadian Sides	1	70 0	71 0	77 5
Danish Sides	1	74 7	79 0	86 10
Dutch (Green, Wiltshire Style)	1	69 10	71 0	98 0
Polish („ „ „)	1	69 10	71 4	84 0

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(*Compiled from Returns received from the Department's Market Reporter*)

DESCRIPTION		QUALITY	MARCH	APRIL	MAY
FRUIT :—					
Apples—	per		*s. d.*	*s. d.*	*s. d.*
Irish, Cooking	cwt.	1	18 0	..	..
American	case.*	1	11 6	12 4	13 2
,,	barrel.†	2	27 3	30 7	..
Australian	case.*	1	..	12 5	11 6
New Zealand	,,	1	..	..	11 3
Canadian..	,,	1	9 10	..	..
Pears, Californian ..	,,	1	12 5	15 5	18 0
Strawberries, English ..	lb.	1	..	..	1 2
,, Imported	,,	1	..	..	1 0
Gooseberries, Imported	,,	1	..	..	0 4
VEGETABLES :—					
Beet	cwt.	1	5 0	5 0	4 7
Brussels Sprouts ..	,,	1	10 8	..	..
Cabbage—					
Coleworts	dozen.	1	1 0	1 0	1 0
Red	,,	1	2 6	2 6	2 6
Savoy	,,	1	1 5	1 6	..
Carrots	cwt.	1	5 0	4 11	5 5
Cauliflowers—					
Broccoli, Cornish ..	dozen.	1	4 0	4 0	4 9
Other British	,,	1	3 0	2 9	3 1
French	,,	1	4 5	4 5	4 6
Italian	,,	1	4 4	4 9	..
Celery	bunch.	1	1 3	1 0	..
Cucumbers	dozen.	1	9 2	7 6	5 10
Greens ..	dozen bunches.	1	6 0	6 0	..
Leeks .. .. ,,	,,	1	2 5	2 4	2 0
Lettuce, Cabbage ..	dozen.	1	2 6	2 0	1 8
Onions—					
Spring	bunch.	1	0 5	0 4	0 3¾
Egyptian	cwt.	1	6 6	7 8	6 10
Dutch	bag.‡	1	5 8	4 0	..
Valencia	case.§	1	8 1	8 0	..
Parsley	cwt.	1	15 2	12 0	10 10
Parsnips	,,	1	7 0	6 6	6 0
Radishes	dozen bunches.	1	2 1	1 8	1 3
Rhubarb ..	cwt.	1	26 10	7 0	2 10
Spinach	stone.	1	4 10	4 0	3 0
Tomatoes—					
Scottish, National Mark "A.A."	lb.	1	..	..	0 11
English	,,	1	..	1 9	..
Channel Islands ..	,,	1	..	1 7½	0 10¾
Canary	,,	1	0 3½	0 4¾	0 3¾
Dutch	,,	1	..	1 0	0 8¼
Turnips	cwt.	1	1 9	1 9	2 4

* 40 lb. (approx.). † 9 stone (approx.). ‡ 7½ stone (approx.). § 9 stone (approx).

POTATOES : Monthly Average Wholesale Prices per ton at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	FIRST EARLIES	SECOND EARLIES	LATE VARIETIES: RED SOILS: Golden Wonder	LATE VARIETIES: RED SOILS: Other	LATE VARIETIES: OTHER SOILS: Golden Wonder	LATE VARIETIES: OTHER SOILS: Other
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
		MARCH					
Aberdeen ..	1	..	..	..	..	2 19 6	1 19 6
Dundee ..	1	..	..	..	..	..	2 3 6
Edinburgh ..	1	..	..	..	..	..	2 1 8
Glasgow ..	1	..	1 16 0	..	..	3 16 0	2 0 0
		APRIL					
Aberdeen ..	1	..	..	..	..	2 8 2	1 13 2
Dundee ..	1	..	..	..	..	..	1 14 5
Edinburgh ..	1	..	..	..	..	..	2 0 0
Glasgow ..	1	..	1 10 8	..	..	3 8 9	1 13 9
		MAY					
Aberdeen ..	1	..	..	..	..	2 13 0	2 2 0
Dundee ..	1	..	..	..	..	..	2 3 0
Edinburgh ..	1	..	..	..	..	..	2 17 6
Glasgow ..	1	..	2 6 3	..	..	3 12 0	2 9 6

ROOTS, HAY, STRAW, AND MOSS LITTER : Monthly Average Prices per ton at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	ROOTS: Carrots	ROOTS: Yellow Turnips	ROOTS: Swedes	HAY: Rye Grass and Clover	HAY: Timothy	STRAW: Wheat	STRAW: Barley	STRAW: Oat	MOSS LITTER
		s. d.	s. d.	s. d	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
		MARCH								
*Aberdeen ..	1	..	..	..	50 0	..	..	..	27 6	..
†Dundee ..	1	..	..	14 10	76 0*a* 64 0*b*	..	49 0	..	49 0	50 9*c*
‖Edinburgh ..	1	..	..	..	52 6‡	..	32 6	..	32 6	..
*a*Glasgow ..	1	..	..	..	55 0	60 0	37 6	..	35 0	31 3*d*
		APRIL								
*Aberdeen ..	1	..	..	..	50 0	.	..	..	28 9	..
†Dundee ..	1	..	..	14 3	78 9*a* 61 3*b*	..	45 0	..	43 9	50 0*c*
‖Edinburgh ..	1	..	..	..	52 6‡	..	31 11	..	31 11	..
*a*Glasgow ..	1	..	..	..	55 0	60 0	37 6	..	35 0	31 3*d*
		MAY								
*Aberdeen ..	1	..	..	..	50 0	..	..	..	25 0	..
†Dundee ..	1	..	..	14 10	71 0*a* 61 0*b*	..	49 0	..	50 0	50 0*c*
‖Edinburgh ..	1	..	..	..	55 6*a* 54 6*b*	..	28 0	..	28 0	..
*a*Glasgow ..	1	..	..	..	55 0	60 0	36 6	..	33 0	31 3*d*

* Ex-farm, loose.
† Baled and delivered in town.
‖ Bunched straw, delivered.
‡ Delivered, baled or loose.
a Baled and delivered.
b Delivered, loose.
c Dutch moss litter, at quay.
d Home moss litter. in 1½-cwt. bales.

FEEDING STUFFS : Monthly Average Prices per ton at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	MARCH		APRIL		MAY	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
Linseed Cake—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Home	8 8 6	8 8 0	8 3 5	8 1 3	8 5 0	8 3 0
Foreign	8 1 3	..	8 0 0	..	8 0 0	..
Decort. Cotton Cake ..	7 8 6	..	7 6 3	..	7 6 6	..
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	5 14 6	5 15 0	5 15 0	5 15 11	6 3 0	6 3 0
Bombay (Home manufactured)	..	..	..	..	..	5 10 6
Palmnut Kernel Cake ..	7 12 6	..	7 12 6	..	7 8 6	..
Soya Bean Cake	8 0 0	..	8 1 3	..	8 5 0	..
Coconut Cake	8 2 6	..	8 2 6	..	7 18 0	..
Groundnut Cake, undecort.—						
(37 % Oil and Album.)	..	6 17 6	..	6 10 8	..	6 7 6
(50 % do. do.)..	..	7 15 0	..	..	..	..
Maize Germ Cake, Home mfd.	7 7 3	..	7 4 5	..	6 17 9	..
Maize Germ Meal	5 10 9	..	5 5 8	..	5 5 0	..
Rice Meal	5 5 9	4 18 2	5 0 8	4 15 0	4 18 0	4 15 0
Bean Meal	7 10 3	7 16 0	6 19 8	7 6 3	6 19 9	7 15 0
Barley Meal	6 16 3	6 15 0	6 13 5	6 15 0	6 16 6	6 7 6
Fish Meal	14 16 0	14 14 6	14 8 2	14 10 0	14 1 6	14 2 0
Maize Meal—						
Home manufactured ..	5 14 0	5 13 6	5 11 3	5 10 8	5 13 6	5 11 6
South African (Yellow) ..	5 8 0	..	5 5 8	5 7 6	5 8 3	5 8 2
Locust Bean Meal	6 12 6	5 17 6	6 12 6	5 17 6	6 15 0	5 17 6
Maize Gluten Feed (Paisley)	5 15 0	..	5 15 0	..	5 6 0	..
Maize—						
Plate	4 16 8	4 15 0	4 12 1	4 13 2	4 15 6	4 14 0
African	5 4 0	..	5 0 0	..	5 4 6	..
Oats—						
Home	5 15 0	5 8 6	5 15 11	5 12 6	5 15 3	5 12 6
Plate	5 17 0	5 7 3	5 6 7	5 8 2	5 9 6	5 7 6
Canadian, No. 2	6 0 0	..	6 5 10	..	6 5 0	..
,, No. 3	5 10 0	..	5 17 6	..	5 17 6	..
Barley (Home)	6 5 0	5 16 0	6 3 5	6 3 9	6 8 6	5 19 0
Wheat—						
Home	6 9 6	5 19 0	6 6 11	6 4 5	6 8 6	6 4 6
,, (Poultry)	5 17 6	..	6 3 9	..	6 7 9	..
Imported	6 12 3	6 0 0	6 10 11	6 2 6	6 14 9	6 3 9
Middlings (Fine Thirds or Parings)	5 15 6	5 10 0	5 10 0	5 5 0	5 11 9	5 5 6
Sharps (Common Thirds)	5 7 6	5 4 0	5 0 8	4 18 2	4 15 6	4 16 6
Bran (Medium)	5 8 6	5 11 0	5 1 11	5 2 6	4 13 9	4 15 0
,, (Broad)	5 7 0	6 10 10	5 1 11	5 17 6	4 15 3	5 10 6
Malt Culms	5 7 6	5 6 3	5 7 6	5 0 0	5 5 0	5 0 0
Distillers' Mixed Grains (Dried)	..	7 13 6	..	7 5 0	..	7 0 6
Distillers' Malt Grains (Dried)	7 12 0	..	7 7 6	..	7 0 6	..
Brewers' Grains (Dried) ..	6 12 6	5 14 0	6 11 11	5 3 2	6 6 9	5 2 0
Crushed Linseed	13 10 0	..	13 10 0	..	13 10 0	..
Locust Beans (Kibbled and Stoned)	5 16 3	5 15 0	5 15 11	5 15 0	5 16 3	5 15 0
Beans—						
China	6 12 0	..	6 3 9	..	6 1 3	..
English	6 15 6	7 5 0	6 10 0	7 5 0	6 9 6	7 5 0
Egyptian	6 9 6	..	5 18 2	..	5 18 6	..
Rangoon (White) ..	..	5 10 0	..	5 8 0	5 10 0	5 9 2
,, (Red)	..	..	..	5 8 0	..	5 10 0
Pease—						
Calcutta (White)	9 0 6	..	8 16 11	..	9 18 9	..
Karachi (,,)	8 9 6	..	8 6 11	..	9 12 6	..
Feeding Treacle	5 0 6	5 10 0	5 0 0	5 10 0	5 0 0	5 10 0
Linseed Oil, per gall. ..	0 3 2	..	0 3 3	..	0 3 3	..

FERTILISERS : Monthly Average Prices per ton at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	MARCH		APRIL		MAY	
		Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	%	£ s. d.	£ s. d.	£ s. d.	£ s. d,	£ s. d.	£ s. d.
Nitrate of Soda *	N. 15·5	8 16 0	8 16 0	8 16 0	8 16 0	8 16 0	8 16 0
Sulphate of Ammonia (Neutral and Granular) * ..	N. 20·6	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0
Calcium Cyanamide †	N. 20·6	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
Nitrochalk * ..	N. 15·5	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0
Superphosphate ..	P.A. 13·7	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6
„ ..	„ 16·0	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
„ ..	„ 18·3	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
Ground Mineral Phosphate ** ..	P.A. 26	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6
„ „ „ ** ..	„ 34	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Potassic Mineral Phosphate	P.A. 18 Pot. 10	3 16 3	..	3 16 3	..	3 16 3	..
„ „ „	P.A. 20 Pot. 7·5	3 10 0	..	3 10 0	..	3 10 0	..
Kainit (in Bags) ..	Pot. 14	3 12 6	3 5 0	3 12 6	3 5 0	3 12 6	3 5 0
Potash Salts ..	Pot. 20	4 5 0	..	4 5 0	..	4 5 0	..
„ „ ..	„ 30	5 15 0	5 5 0	5 15 0	5 5 0	5 15 0	5 5 0
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	10 2 6	9 15 0	10 2 6	9 15 0	10 2 6	9 15 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	12 0 0	11 12 6	12 0 0	11 12 6	12 0 0	11 12 6
Steamed Bone Flour	N. 0·8 P.A. 28	6 0 0	..	6 0 0	..	6 0 0	..
„ „	N. 1 P.A. 60	..	5 10 0	..	5 10 0	..	5 10 0
Bone Meal (Indian)	N. 4 P.A. 20	7 0 0	..	7 0 0	..	7 0 0	..
„ „ „	N. 4 P.A. 45	..	7 5 0	..	7 5 0	..	7 5 0
Potassic Slag	P.A. 12 Pot. 6	..	3 10 0	..	3 10 0	..	3 10 0
Basic Slag ‡ ..	P.A. 13	2 1 6	1 17 6	2 1 6	1 17 6	2 1 6	1 17 6
„ „ ..	„ 14	2 3 0	1 19 6	2 3 0	1 19 6	2 3 0	1 19 6
„ „ ..	„ 15	2 7 0	2 1 6	2 7 0	2 1 6	2 7 0	2 1 6
„ „ ..	„ 16·5	2 13 0	..	2 13 0	..	2 13 0	..
„ „ ..	„ 17·5	2 16 0	..	2 16 0	..	2 16 0	..

Abbreviations :—N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

** Fine grist, 90 per cent. fineness through prescribed sieve.

‡ Prices for Basic Slag at Glasgow :—F.o.r., in 6-ton lots, 80 per cent. citric soluble and 80 per cent. fineness; at Leith :—6d. per ton higher, if carriage paid to Border Stations.

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THE NITROGEN HUNGER OF THE WORLD[1]

Professor Sir FREDERICK KEEBLE, Sc.D., F.R.S., M.R.I.

THE story of the transmigrations of nitrogen is an epic meet for a poet's pen: a realistic story of escape and capture; a romance of freedom and of bondage. Told in cold prose it can scarcely be popular; for it is old-fashioned; a story with a moral, and morals—at all events in stories—are out of date. The moral moreover is irksome, as all good morals are. It warns the world that unfettered freedom such as nitrogen enjoys as it mopes about, remote, unfriendly, alone in the atmosphere is no good either for it or for anything else. It is only when its forces are joined with those of others that nitrogen livens up; for free nitrogen is a denial of life, combined nitrogen is its shrine. That vast mass of nitrogen, which makes up nearly four-fifths of the atmosphere, provides a grim spectacle of unemployment. Atmospheric nitrogen passes in and out of our lungs unchanged, although our bodies may be hungering for it; yet that same nitrogen when linked chemically with carbon and other elements becomes the breath of life.

Until the present century the freedom of nitrogen to resist fruitful union with other elements remained unchallenged save only by two natural agents: the thunderstorm and that amazing micro-organism, the nitrogen-fixing bacteria, which bring the free nitrogen of the atmosphere into the charmed circle of life. Now, however, a mightier agent—man the chemist—has mastered this refractory element. Having given loyal effect for so long to the first clause of the primal divine ordinance "be fruitful and multiply," mankind are diverting their obedience to the fulfilment of the latter clause "replenish the earth and subdue it."

The chemist has intervened to redress the balance of the old world by calling in a new: a new world wherein never more need the gaunt spectre of famine stalk the earth and where health shall be the rule and disease the rare exception: the world of nitrogen plenty.

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[1] *Address delivered before the Royal Institution of Great Britain.*

Prometheus brought down fire from heaven: a new Prometheus has arisen, who brings down fertility from the skies. That old, much worn and very threadbare fabric, the soil, whence comes all life may now at last be renovated—made stronger and more beautiful; for with the nitrogen that man can give it, all things that live upon the earth may grow lustier than they are. Facts attest that this is no empty verbiage.

The earth and the waters under the earth are hungry for nitrogen.

An acre of English meadow land produces on an average little more than a ton of hay. Feed the grass with nitrogen fertilizer, supply its mineral deficiencies in springtime and the acre of land gives at least a two-fold yield. Double the supply of water and at the same time give a double allowance of the nitrogen fertilizer, the yield becomes six-fold. Increase yet further the water and the nitrogen and the natural yield of one ton becomes nine tons. This, which we at the Jealott's Hill Agricultural Research Station have shown to be possible, is a measure of the potency of nitrogen, and an indication of the fierceness of the hunger of the earth for nitrogen.

The waters also are athirst for nitrogen and when their natural supplies are augmented, bring forth life more abundantly. Any watercress bed which lies in clean water will show it. Broadcast a nitrogen fertilizer over a part of the bed and where it falls the cress will grow greener and more vigorous : the very line which demarks the fed from the unfed will be reflected in the different growth on either side of it. The bread of life cast upon the waters is returned after not many days.

The productiveness of the sea no less than that of the land and fresh waters is limited by nitrogen insufficiency. How else to explain the fact that tropical seas support a volume of life less than that of the temperate seas !

Previous to man's intervention, the thunderstorm, by forcing atmospheric nitrogen into union with oxygen, did a little to augment the earth's food supplies, but like most noisy workers its activities did not amount to much. It was the nitrogen-fixing bacteria of the soil that played the part of Atlas in sustaining the world, all the life of it, life of green plants, of animals and of mankind.

They, by ways of synthesis still secret, uniting nitrogen with carbon and other elements, lay the foundation stone on which all the edifice of life is built. The green world of plants which builds the food of mankind has to stand waiting until regiment after regiment of other soil bacteria, wave upon wave, attack and break down, step by step, the organic residues left by the nitrogen-fixing bacteria, until at last a simple compound of nitrogen—ammonia—is produced ; and every dunghill testifies by its ammoniacal odour to the final stage of this disintegrating process on which the life of green plant and animal and man has had to wait.

Even so, the nitrogenous food which most green plants use is not ready for them. They must still go on waiting until other kinds of bacteria—the nitrifying bacteria of the soil—oxidize the ammonia into nitrates, the form of combined nitrogen which serves as food for the majority of green plants. But hunger begets impatience and under its stress green plants have been driven to adopt many and varied expedients for securing nitrogen food. Some, the clovers, vetches, and other legumes, as well as plants belonging to other families have acquired the power of tapping supplies of nitrogen at the source. They admit the nitrogen-fixing bacteria into their roots, forming a home for them by enlarging the tissues of the root into nodules. The nitrogen-fixing bacteria enter readily, for there in the root of the green plant they are assured of plenty of the carbonaceous food, in the form of sugar, which they need. In return for these supplies the nitrogen-fixers yield up to the plant the organic nitrogen compounds which they synthesise and in this elegant way the leguminous plant solves its nitrogen problem. Other plants also steal other marches on their fellows. As was shown long ago almost any green plant can in emergency make use of almost any kind of nitrogen compound: but in nature plants do not often get a chance to show their catholicity of taste, for the soil bacteria are there before them. Not a few plants, however, instead of waiting for the production of nitrate by the nitrifying bacteria absorb nitrogen in the form of ammonia. When I became convinced of the intense struggle for nitrogen which goes on among the plants of pasture lands, I suggested that some at least among the grasses must have been driven to this expedient. There were agricultural experts who were sceptical. They told me that I must prove my statement if I wished to preserve my reputation. There was no need : for in the meantime it had been proved that what ought to be is, that grasses are in fact able to get supplies of nitrogenous food in the form of ammonia. There is, however, danger to the plant in the adoption of this habit. Grasses and other plants may thrive on ammoniacal food, but to others it is poisonous, a fact which anyone can prove by dressing liberally a weedy lawn with sulphate of ammonia. All the plants of the lawn are hungry for nitrogen and all absorb the ammonia with the result that the grasses thrive and most of the weeds die.

The expedients used by green plants to obtain supplies of nitrogen are well-nigh endless. Some plants become saprophytes. Such plants, no longer green although they once were, to be found in beech woods where they are living on decaying vegetable matter, may be recognized by their dull brown colour. Having found large supplies not only of nitrogen but also of carbon compounds, they are no longer constrained to make their own carbonaceous food as green plants must. They haul down the green colours of their independence and hoist the dingy brown flag of piracy which declares their animal-like, saprophytic practices. Stress of nitrogen hunger has driven other green plants to yet more thorough-going piracy. It has made them parasites. There is indeed no doubt in my mind that all parasitism, both that of plants and of animals, is the outcome of nitrogen hunger. By it the parasite is driven to raid the stores of nitrogen contained in the host's body and by it, the host, insufficiently fed, comes to lack the power to repel the attack.

It might be supposed that if life would only be patient—it would not be life if it were—all must come right in the end. The nitrogen-fixers would go on working and presently there would be enough nitrogen for all. It is not so. Obscure forces are at work to undo the labours of the nitrogen-fixing bacteria. There are forces which lock up the stores of organic nitrogen in the soil and there are forces which dissipate them altogether.

Soil bacteria other than those which break down organic nitrogen by gradual stages into ammonia may set the nitrogen free again and in the interplay of these ammonia-forming and nitrogen-liberating bacteria are to be discovered the secrets of soil fertility and infertility. As the eye may see white mists arise in winter from water-logged fields, so may the eye of imagination see an invisible mist of nitrogen arising with the watery wintry mists, escaping from an earthy prison to regain the freedom of the skies.

The living earth may also lock up nitrogen out of reach of the roots of green plants. Life, therefore, must depend on the resultant of these opposing forces, the nitrogen-fixers and the nitrogen-liberators and hoarders. There is no reason to suppose that the resultant has always been the same. There may have been epochs in the earth's history when the forces of construction have prevailed. In those periods the nitrogen-fixers endowed life unstintingly with their gifts. Life burgeoned forth in exuberance and beauty. There may have been other periods alternating with these in which the nitrogen-liberators prevailed. Nitrogen, instead of accumulating on the earth, increased in the atmosphere. During these periods the world would show an almost imperceptible, but ultimately fatal decline in fertility. Nitrogen set free in increasing measure would mean life in ever closer bondage, in bondage to inevitable parasitism and to all manner of disease. Perhaps every geological epoch has seen these changes and has gone this way along the road to dusty death : now a waxing, now a waning of life : each geological epoch one complete heart-beat of life, a diastole and a systole; the one the outcome of nitrogen plenty, the other of scarcity.

A new land arises from the sea : its limestone rocks the multitudinous tombs of living beings of past epochs, and like the tombs of Egyptian kings full of treasure. The rocks are rich in lime and phosphates, in potash and in iron and in all those other known and unknown elements indispensable to life. Life gave and life will take them away. But that new land that has risen from the sea is as yet barren. Presently nitrogen-fixing bacteria borne by wind or water are sown over it. The richness of the land in phosphates encourages them to grow luxuriantly. Generation succeeds generation, each bequeathing a heritage to the earth. The earth is fertilized by their activity and their decay. It brings forth more and more abundantly. Mighty tree and mammoth animal arise. A golden age! But as the centuries pass rain and wind wash away and blow away the minerals and the very soil itself. The phosphates, no less essential to life than is nitrogen, begin to fail. The failure may be seen to-day in most parts of the southern hemisphere and in much of the northern hemisphere as well. With the decline in phosphates the activity of the nitrogen-fixing bacteria languishes. They bring less nitrogen into the vital circulation. Life declines. Trees shrink to the size of shrubs and shrubs are dwarfed to herbs; a change which botanists, basing their conclusions on anatomical grounds, aver has overtaken the vegetation of the present epoch. Even the herbage becomes scantier with the increasing default of nitrogen. The green mantle which should protect the earth from the elements wears threadbare. Rains rend it. Ravenous animals make the rents wider by over-grazing; until at last the mantle of the earth is all brown and tattered. A once smiling land teeming with life becomes a lifeless desert.

I stood on the veldt of South Africa and with the eye of imagination saw these things come to pass. I saw the scant herbage grazed by few and hungry cattle. Here, I said, is a desert in the making. They tell me that it is lack of rain which makes a desert. I am not satisfied with the explanation. It is lack of nitrogen and minerals which aggravates the ill-effects of low rainfall and causes such rain as does fall to run to waste. You may see rivers there after rain run red as though with blood: it is the life-blood of the land, the red soil which they are carrying to the sea. We put nitrogen fertilizer on the veldt. The starved grasses began to grow. The brown herbage became green, and I dare to prophesy that nitrogen will prove the salvation of South Africa.

I return home and watch in springtime the long drawn-out struggle of the South Downs to change their ashen grey and dull brown winter colour into summer greenness. Their pallor is a symptom of starvation—of nitrogen starvation. The trained eye sees in the varied hues of vegetation the distress signals of its privations. Yellowness where dark greenness should be proclaims nitrogen starvation. A lack of emerald tone in grassland signals insufficiency of phosphates and brown-flecked foliage declares a shortage of potash.

Must those Downs on which the sun of springtime is shining go on waiting until summer is at hand before life—green life—can begin to make them radiant? The answer will show the potent magic which nitrogen can work in the world. Broadcast one or two hundredweights of sulphate of ammonia over those grey Downs, or over any of our pasture lands in early spring; growth no longer lingers. The grass grows green and strong and cattle may be grazing it weeks before there is grass for them to graze on neighbouring pastures. This fact we have demonstrated on many farms in many parts of Great Britain. Of 492 experiments which I caused to be made, 447—91 per cent.—showed the spring grass growing a fortnight or even a month before it grew on the pastures left to look after themselves.

The power of nitrogen to produce an " early bite " has of course practical value. It may save the farmer half a million pounds sterling or more each year; for he is able to turn his cattle out earlier and need spend less on artificial feeding stuffs. But the scientific consequences which have resulted from the inquiry into the cause of this precocity of growth are of greater importance; for they offer a new point of departure for the study of soil fertility.

Why should nitrogen provoke precocious growth of grass in spring? I used to worry all my colleagues day after day with the question. They could not answer it. Neither could I. It was too simple. Then I recalled John Hunter's brusque retort when Jenner said to him: " I think I have discovered a remedy for smallpox." " Don't think, try," said Hunter. We tried. It is well known that grass like any other plant does not grow unless the temperature is high enough. Growth of the early grass of pastures begins when the temperature rises 10 or 11 degrees F. above freezing-point and goes on increasing as the temperature rises. Our nitrogen grass—the grass to which nitrogen fertilizer is added in spring—begins to grow vigorously at the minimal temperature. The natural grass by the side of it does not. Needless to say warmth alone cannot make grass grow. Food is also necessary. Therefore the nitrogen grass must be better fed than natural grass. But why? Pasture land contains humus. Humus, the partially decayed residues of vegetable tissues, is full of nitrogen. Hence it cannot be lack of nitrogen in the soil that causes the laggardliness of spring growth. We had taken care to add to both the natural and the nitrogen grass the phosphates and potash in which they might be deficient. Therefore, so we argued, the laggardliness must be due to lack of nitrogen plant food. If so, it can only be because the natural store of humus nitrogen in the soil does not readily supply the nitrogen food for which the grass is craving. Following this argument my colleagues, Messrs Blackman and Lewis, carried out a simple but beautiful investigation. Sulphate of ammonia was added to grassland in spring and the amounts which could be recovered from the soil were measured. The results show that when the soil is cold some of the nitrogen which was added to it could not be recovered. The soil had locked it up. The nitrogen was withdrawn from circulation: hoarded in the soil bank. But if this can happen to some of the ammonia added to the soil it must also happen to the nitrogen plant foods already there. They too are locked up. Like gold in vaults, the nitrogen plant foods of the soil in springtime are a frozen asset. The grass roots cannot get nitrogen and their stems and leaves, deprived of it, cannot grow. Life in the pasture stands still—waiting.

But what kind of a bank may this soil nitrogen bank be? For my part there could be no doubt. "Give the soil an anæsthetic," I said. "Hold the bank up in the approved style of modern hold-ups." We did. The bacterial personnel put up their hands. The bank disgorged its treasure. The soil yielded up all the ammonia which had been added to it. The riddle is half read. In natural pasture in spring, even though the temperature is high enough, no growth occurs because the nitrogen-building materials necessary for growth are lacking. The other half is easy to resolve. The nitrogen grass grows. Therefore it must possess already the building materials for growth. But the nitrogen-building materials which plants use are complex organic substances, proteins and the like; the same things as those which human bodies use. It must therefore be that, when plenty of nitrogen is available, the roots begin to absorb it at temperatures lower than those at which growth of the leaf and stem is possible; and not only absorb it but work the simple nitrogen plant food up into the complex organic building materials which leaf and stem use for growth: a low temperature synthesis which even the modern chemist cannot imitate!

Give sulphate of ammonia to the grass in early spring: ammonia is absorbed by the roots and is converted into organic form against the time when soil and air are warm enough for grass to grow. It grows abundantly; but if nitrogen be not given, when there is warmth enough for growth, the building materials are not there in sufficient quantity and growth must languish till they are.

Science does not put a ban on fairy tales. If she did who would listen to her? But science does re-edit them, makes them longer and longer and more fascinating. The fairy prince, the sun, bends over the sleeping beauty of the earth. If, as he used to do, he essays to waken her merely with the warmth of a kiss, she responds with a disappointing languor, but now when a little present is offered as well her awakening is instantaneous.

What is true of pasture is also true of arable land. Both suffer from the lock-up of soil nitrogen at low temperatures. I conducted one of our leading scientific agriculturists round the farm at Jealott's Hill in the late spring of last year. We came to a crop of potatoes. Some of them were yellow and not too well grown. "Ah!" he said, "there is your nitrogen starvation." "You are right," I replied, and paused. He was pleased, but less so when I added: "They have only had twenty tons of farmyard manure to the acre." And then I expounded the doctrine of nitrogen lock-up by the soil which, needless to say, will have always been known when people become familiar with it. I was able to do so because of the results of experiments which we had made a year or two before at Jealott's Hill. We grew potatoes under four different conditions. One lot received 10 tons of farmyard manure to the acre, another 20 tons, a third 30, and lest there should be any insufficiency of other plant foods, phosphates and potash were added in amounts large enough to allow of high yields. The fourth plot got nothing but artificial fertilizers containing nitrogen, phosphates and potash in quantities sufficient for a large crop.

The yields per acre were :

The 10-ton manure plot . .	5½ tons of potatoes.
The 20-ton manure plot . .	10¾ ,, ,,
The 30-ton manure plot . .	12 ,, ,,
Complete fertilizer . . .	12 ,, ,,

The 10 tons of manure contained more nitrogen than was supplied by the complete fertilizer and yet it produced less than half.

But crops of equal size contain about the same quantity of nitrogen and therefore the potatoes growing in the 10-ton manure plot must have got less than half the quantity of nitrogen that was absorbed by those grown with the complete fertilizer. They went hungry in the midst of plenty. Plants need nitrogen when they are young ; but the soil bank withholds nitrogen. It leaves them hungry with the natural result that plants' powers of growth and development are permanently impaired. It is only when the nitrogen supply of the farmyard manure is increased threefold—to 30 tons to the acre—that enough becomes available for the production of a crop equal to that of the potatoes that had access to the smaller quantity but more readily available form of nitrogen contained in the artificial fertilizer. It is a matter of common experience among farmers that the addition of a nitrogen fertilizer to soil already rich in humus nitrogen often leads to a marked increase in the crop and the explanation of the fact is now self-evident. It is also evident that the nitrogen hunger of the world, due primarily to the deficiency of combined nitrogen on the earth, is aggravated by the nitrogen-hoarding proclivities of the soil, and that these proclivities are the expression of the activities of soil micro-organism.

Low temperature is not the only condition which may lead the soil to withhold the nitrogen that plants need. Drought also may do it as we discovered in the course of our experiments at Jealott's Hill. The experiment was being made in order to obtain a measure of the extra yield which results from supplying grassland with nitrogen. There was a severe summer drought. Growth ceased. The drought lasted several weeks. Rain came at last. The grass which had had a nitrogen fertilizer soon began to grow again, but the natural grass stood still for a week or more and the check which it had sustained was evident in the poorer growth made by the natural grass throughout the rest of the season.

Nor is it surprising that in times of drought soil bacteria should beat the green plant in their competition for nitrogen. The green plant is of aquatic origin. It still acknowledges its ancestry in its dependence on large and constant supplies of water. Bacteria, minute and chitinous-coated, can sustain drought better and so in droughty times the green plant is defeated by the soil bacteria.

It is a truism that the natural caution of mankind is nowhere exercised more rigorously than in the domain of new ideas. The cautious say: "That early growth of yours will lead to poorer growth later on." Of course it will, if the grass is left to starve: if it gets only one meal a year; but feed it at intervals and the growth of the nitrogen grass throughout the season is more than double that of natural grass.

Nor is it grass alone that suffers from the slowness with which the earth gives up its stores of nitrogen in spring. Apple trees, as all growers know, are apt to bear large crops only in alternate years. They have their on and off years. The year of plenty claims large supplies of nitrogen for the fruits. The leaves, when they begin to grow, have to live on short commons. They remain small. Their work suffers. They make little provision of food for next year's crop. The fruit crop suffers in turn: the off year. But if nitrogen be given in early spring before the flowers appear, the roots absorb it. The tree works it up into plant building material and there is plenty for flowers, fruits and leaves, and so every year becomes an "on" year. Prospero's elves must surely have known all about the way to circumvent the vagaries of the earth with respect to nitrogen when they sang:

> Earth's increase, foison plenty,
> Barns and garners never empty;
> . . . . .
> . . . . .
> Spring come to you, at the farthest,
> In the very end of harvest.

Not only must crop-plant, soil and soil bacteria be taken into account if the mysteries of soil fertility are at last to be revealed. Variety of crop plant must also be considered. For example, wheat is a plant which is supposed to resent much nitrogen. If heavily manured it lodges in wet and windy weather: falls prone on the earth and may shed its grain before harvest. Some of the varieties of wheat commonly grown in this country undoubtedly lend support to the opinion that plenty of nitrogen is bad for the crop. Yet the yield of wheat in this country, good as it is in comparison with that of other countries, is lower than it should be. We get on the average about 18 cwt. to the acre to Germany's 15 and France's 11½. But Holland, which uses far more nitrogen fertilizer than we do, gets 23 cwt. Experiments made by Jealott's Hill on farms covering 2500 acres under crops show that by the use of nitrogen our yield can be raised from 18 to 22 cwt. per acre—an increase of 22 per cent. The readiest means of bringing about this increase is the growing of varieties of wheat which are capable of using, without ill-effects to themselves, large quantities of nitrogen. It is only to be expected that the varieties commonly grown in this country should be those which have proved themselves to give consistent and fairly high yields under average farm conditions. Those conditions include a restricted ration of nitrogen in the soil. These varieties are so inured, if not to poverty yet to abstemious habits, that they cannot make profitable use of plenty when at last it is offered to them. Give them more than a bare allowance of nitrogen and the extra ration results in but a small increase of yields.

Squarehead Master, a popular variety, is an example of an abstemious kind of wheat. An extra allowance of nitrogen calls forth only a small increase in its crop. In one of the Jealott's Hill experiments a supplementary ration of nitrogen resulted in Squarehead Master producing to the acre only 2⅔ cwt. more grain and 6⅔ cwt. more straw than were produced by a smaller ration of nitrogen. But the response of other varieties not inured to abstemiousness was very different. One of them, Chevalier, responded to the larger nitrogen ration by producing 7½ cwt. more grain and 17 cwt. more straw than were yielded when the smaller ration of nitrogen was provided for its use.

Anyone who has read thus far may well be tempted to ask: "What is the use of showing how to increase food production when the granaries of the world are already bursting with superabundant corn? Several answers might be given. One that the use of fertilizers cheapens production and, though it swell the volume of commodities, the farmer who produces most economically stands the best chance of surviving. That is answer enough for the farmer.

Another reply would urge that the apparent over-production is but a passing phase; but to develop that line of argument lies beyond my competence. My answer is very different. To supply the shortage of nitrogen and mineral plant foods from which the soils of the world are suffering is the only way to produce the kinds of food which will maintain and improve the health of mankind.

By this means, as I believe, the maladies and diseases of mankind can be banished from the earth. I will describe the line of thought which has led me to this conclusion.

Our experiments at Jealott's Hill showed us that a moderate use of nitrogen and mineral fertilizers doubles the yield of protein from grass. The increase in protein is accompanied by a corresponding increase of carotene. As the carat is a measure of purity of gold, so carotene is a measure of the nutritive virtue of grass and of the milk and butter derived indirectly from it. Carotene, a simple compound of carbon and hydrogen, suspected of playing an important part in the life of plants, is known to play an essential part in animal life. Introduced into the body of an animal, carotene is assembled in the liver. That organ does to carotene what the stone-breaker by the roadside does to the stones; albeit with more meticulous accuracy. It breaks the carotene, molecule by molecule, in halves, and the halves—or some of them—are vitamin "A", one of the vitamins which encourage growth and enable the body to resist disease.

Nitrogen grass supplies a double allowance of carotene to the grazing animal: the milch cow for example.

For some years now Jealott's Hill has been drying nitrogen grass artificially and using it for the winter feeding of dairy cows. Professors Heilbron, Drummond, Dr Morton and other distinguished biochemists have been co-operating in this work. The dried grass has proved a perfect substitute for a large part of the concentrated food usually fed in winter to dairy stock. Home-grown grass may in large measure replace imported feeding stuffs.

In order to test the quality of the milk produced by animals fed on the winter ration of dried nitrogen grass, the milk was made into butter. Analyses made by Heilbron and Drummond and their colleagues show that the butter is far richer in carotene than that made from milk from cows fed on the ordinary winter dairy ration. The butter itself confirms the conclusion. For whereas that made from the milk of cows fed on ordinary concentrates together with hay or silage and mangolds is of the palest yellow colour—almost chalky white—the butter from the milk of cows receiving a large ration of dried nitrogen grass is of a deep primrose yellow—and moreover has the true buttery appetizing flavour which appears to be nature's way of announcing the virtues of good butter. The dried grass produced summer milk and summer butter in winter.

It need scarcely be said that there is far more to be learned of the subtleties of nutrition than is yet known. The vitamins go on multiplying and the parts played by minerals in nutrition are discovered to be more and more manifold. Our own experiments in feeding animals on dried nitrogen grass indicate, also, that much remains yet to be discovered.

Pasture land gets on well with very little lime. This I attribute to the power of grass to use the same lime over and over again. The roots absorb it. Some of the lime passes into the vital circulation of the plant and some, dumped in the tissues of the grass, returns with their decay to the soil.

When we were comparing the feeding values of nitrogen grass and natural grass, we were disconcerted to find that the former contains less lime than the latter. It is, however, not surprising, for pastures are not rich in available lime and the yield of nitrogen grass is more than double that of natural grass. Yet, despite the fact that the nitrogen grass contains less lime, the milk yielded by cows fed on it contains not less but actually more lime than does the milk produced from cows fed on the natural grass. The paradox suggests that lime may exist in two states in the green plant: a "metabolic" state in which it can be handed on from the grass through the cow to the milk, and an "inert" state in which it can be handed on less surely. Similar possibilities certainly attached to other elements, of which silicon may prove to be one. All the recent great and rapid advance in knowledge suggests that the way to perfect nutrition will be found to lie in the direction of using for food those things wherein life still is.

The discovery that dried grass may result in the production of summer milk and butter in winter and that these foods contain large amounts of carotene provokes the audacious thinker to make a further step in his conjectures. When winter comes can 'flu be far behind ? May it not prove that that winter scourge of mankind, influenza, is encouraged by the insufficiency of vitamin " A " in the winter diet of human beings ? And may not the grass of England's green and pleasant land, if properly used, hold out prospects of making that land yet more pleasant ? Is it over-bold to suggest also that other and yet graver maladies may be fended off when mankind is secure all the year round of supplies of food, lacking none of those numerous and varied vitamins nor any of those obscure but essential minerals which, as we are coming to know, are necessary for the maintenance of health ? May it not prove that tuberculosis for example, both bovine and human, is a deficiency disease and that its ravages are encouraged by the lack of those vitamins which confer resistance to disease. Winter comes. The cows go into the byre. Little sunlight reaches them. The winter ration of concentrates, poor in carotene, replaces the fresh herbage rich not only in carotene but in other vitamins as well. Of such winter supplies of vitamin " A " as the cow gets, some, perhaps much, passes into her milk. Her own body is impoverished, and the bacillus of tubercle finds its occasion.

I told Professor Armstrong the results of our experiments on the feeding of dried grass to cows and of these reflections of mine. With that alertness of mind which distinguishes him, he determined to help towards putting these ideas to a practical test. Thanks to him it was arranged that grass dried at Jealott's Hill should be supplied to the dairy attached to one of our public schools. Some of the cows received the dried grass in their ration and some of the boys are getting daily their milk. It was only possible, however, to provide each boy with half a pint a day. The doctor of the school is keeping the records, including the measurements and weights of the boys who receive the half-pint. The results so far as the boys are concerned will not be known until the end of the winter term, but it is already evident that the cows fed on the dried grass are in better condition than the others of the herd.

For my part I am convinced that, whatever the results of this necessarily restricted experiment may be, an ampler provision of vitamins in the milk, butter, cheese, eggs and vegetables used for the winter feeding of the people of this country is essential if improvement in national health is to be effected.

The plant world offers manifold evidence of diseases due to deficiencies. Lack of potash causes "leaf scorch" disease in apples, the symptoms of which are discoloured leaves and small fruits. Deficiency of sulphur is responsible for a serious disease of the tea plant in Nyasaland. The researches of Dr Wallace at Long Ashton have shown that fruit trees growing in soil lacking magnesium lose their leaves prematurely. Lack of iron causes chlorosis in many plants as well as bush sickness among cattle and sheep in New Zealand. Another form of chlorosis is caused by a deficiency of manganese. As Rothamsted has shown, leguminous plants cannot thrive without boron. In Florida tomatoes produce only the scantiest crops unless copper in combined form is added to the soil, and crop failures on reclaimed lands in Holland have been remedied by the same means.

Some may find amusement in these oddities of plant nutrition, others, and I am among the number, see in them pregnant hints that imperfect nutrition resulting from deficiencies of diet is responsible for disease—all disease. How subtle deficiency may be and how dependent it may be, not only on the food but also on the feeder, is indicated by the fact that there are plants which are extraordinarily inexpert in obtaining some of the minerals on which their lives depend. There are for example, as has been shown at East Malling Research Station, certain stocks of apple trees which are peculiarly inapt to absorb potash even from soil well supplied with it and I grow in my own garden a variety of apple (Margil) which shows this significant peculiarity.

When I consider the improvement of pastures which may be effected when the natural deficiencies from which they suffer are relieved, I find a new and profound significance in the fact that the first plant to be mentioned by name in the Bible—in the eleventh verse of the first chapter of Genesis—is grass.

Finally, if there be any truth in the conjecture that the world of the past has alternated continuously between phases of nitrogen plenty and nitrogen scarcity, a new and a revealing light may be thrown on the course of evolution. It may reconcile apparently irreconcilable things. The path of evolution is strewn with its victims: its weapons are contention and strife, but its path also is illuminated by all the unimaginable beauty of animate things. The humming-bird, the butterfly's wing, the bizarre beauty of the orchid flower: is all this beauty only a casual by-product or is it an enduring memento of the times when nature endowed lavishly with nitrogen from heaven

> . . . . should bring forth,
> Of its own kind, all foison, all abundance?

Everything that lives bears the harsh imprint of contention and everything that lives bears the soft impress of beauty. Nature unaided contrives here and there oases of plenty in a world of want, and beauty is born there. Man can make the whole world an oasis from which want is banished: a perennially golden age!

RAW *versus* PASTEURISED MILK

(With special reference to the Vitamins)

CHALMERS WATSON, M.D., F.R.C.P.E.
Senior Physician, Royal Infirmary, Edinburgh

A NUMBER of prominent medical teachers have, in recent months, raised their voices and pens in favour of the compulsory pasteurisation of all milk except that of the Certified Milk standard. This recommendation is, in general, at variance with the policy indicated in the existing official regulations relating to the sale of milk, these being based presumably on the views of the skilled medical officers engaged in the Public Health Service. Nor does it accord with the policy which has been directed, for many years, with an increasing measure of success, towards "cleaning up" the dairy herds of the country in relation to tuberculosis and other forms of infection. Can these views be reconciled, and, if not, which is the correct one? These are the questions I have been invited to discuss in this article.

Practical Aspects of the Compulsory Pasteurisation Policy.—Leaving aside for the moment the practical aspects on the medical side, we have to recognise that in the past few years the progress made in regard to the provision of a better milk supply throughout Scotland has been of a remarkably gratifying nature. After many years preliminary spade work by the Departments of Health and Agriculture, the progress made in the past few years has been very striking. There are now over 100 dairy herds licensed for the production of Grade A T.T. Milk, and it is well-known that this number could and would soon be greatly increased if the demand for tubercle-free milk were to increase. It is relevant to state that for many years past milk producers have, rightly or wrongly, laid the blame for the slow progress of the movement on the alleged apathy of the medical profession in regard to the pre-eminent merits of milk as a food. It would be idle to deny that there may be some justification for this opinion. If the present regulations are modified in favour of compulsory pasteurisation, it is practically certain that the existing rapidly progressive movement towards a better milk supply would be seriously and permanently checked. This would be immaterial if it could be established that pasteurised milk had anything like the same nutritive value as clean raw milk, or if it were true that any deficiency in the nutritive value of milk after pasteurisation could be completely met by adding to the dietary an adequate amount of what is termed a "vitamin" (orange juice). Neither of these contentions can be upheld. The crux of this subject, from the scientific aspect, centres very largely on the vitamin question, and unfortunately a very large amount of present day teaching on vitamins has become established much too quickly. On both the scientific and practical side the subject of vitamins is in an extremely unsatisfactory and chaotic state, to a degree which does not appear to be recognised by the exponents of compulsory pasteurisation. In an article on "Intelligence and Heredity," referring to a recent discussion at the British Association at Leicester, a critic sums up the position in the following sentence —"It is not a case of scientists contradicting one another, but of specialists revealing so many disparate aspects of truth that the ordinary man is incapable of seeing the wood for the trees." An even stronger criticism might be applied to the present-day teaching on vitamins. There is conclusive evidence that the results of a vast amount of laboratory research on vitamins, based on experimental work on small animals, has been much too readily accepted as directly applicable to conditions obtaining in man and domestic animals. So much is this the case that there is good reason to believe that unless some check is given to the present tendency, progress in practical medicine will be seriously arrested by present over-specialised scientific research. The grounds for this opinion will be shortly stated. This necessitates a brief reference to the history of what are—possibly unhappily—termed vitamins.

The Vitamins: Early History.—In the light of recent work our first knowledge of vitamins—although the term vitamins was not then applied—was the discovery of the curative influence of fresh foods and vegetables in the treatment of scurvy by Lind in 1757. This great discovery received very tardy recognition. Lind, in his diary, records that traditional beliefs were then as difficult to control as we find them now, for he wrote: "Some persons cannot be brought to believe that a disease so fatal and dreadful can be prevented or cured by such easy means. They would have more faith in some elaborate composition, dignified by the title of an anti-scorbutic golden elixir or the like. It is no easy matter to root up old prejudices, or to overturn opinions, which have acquired an establishment by time, custom and great authorities." The nature of the active property or substance—it is not yet known which—present in fresh fruits and vegetables has not yet been determined. In modern vitamin literature this vitamin is now classified as vitamin C. Good fresh milk has a definite, but in the quantities available, restricted anti-scorbutic value, and it is generally accepted that this anti-scorbutic property is lost or greatly reduced by pasteurisation methods. The opinion generally held on this subject is well stated by Stirling and Blackwood, who say that "The danger of deficiency disease among children undoubtedly exists when pasteurised milk is the only source of vitamin C." It is claimed that this defect in pasteurised milk is readily and wholly compensated by the addition of orange juice to the dietary, but that is, at least extremely doubtful. Even if this was true, which is not accepted, are we to assume that the deficiency would always be met? My experience leads me unhesitatingly to believe that the pasteurisation of milk prejudicially affects the nutritive value of milk in directions other than those associated with any special "anti-scorbutic" property. This much may be regarded as certain—if even a very little of the extraordinary reserve, shown in accepting Lind's teaching, had been in evidence in the interpretation of, and clinical application of the results of laboratory investigation of the milk question to clinical medicine in the past twenty years, the subject of vitamins would not have been in the chaotic condition, in which, from the practical point of view, it finds itself to-day.

The next important advance in our knowledge of vitamins was made by the pioneer work of Little, Holst, and later Eijkman (1897) in relation to the disease Beri beri. Their investigations proved that this very serious and fatal disease was essentially due to the use of decorticated rice grain, the disease being readily cured when the whole grain or even the half-peeled grain was substituted. This therapeutic substance or property—later designated vitamin B—is known to be present in whole meal flour, whole barley, whole or half-peeled rice, and to be absent in white flour, pearl barley, and white rice. There are now subgroups of this particular vitamin B, based essentially on highly specialised lines of laboratory research. Cows' milk, it may be added, is relatively rich in this vitamin. It is generally stated that this vitamin can withstand a much higher degree of heat treatment than that encountered in pasteurisation. This is pure assumption. So far as I am aware there are no known facts either on the scientific or purely clinical side which justify any opinion on the point. Vitamin B has never been isolated, the origin and nature of the protecting and curative agent in the whole grain or other food products never having been determined.

This brings us to the two vitamins A and D. The recognition of these vitamins in 1912 laid the foundation of our present knowledge of the vitamin question—or to be more exact—the present assumed knowledge of the subject as that has been set forth by laboratory workers, too readily accepted as sound by clinical teachers and practitioners, and extensively exploited on commercial lines. The present position of the question, more especially in its clinical aspects, recalls to the writer a criticism of modern scientific research as that has been recorded at the recent meeting of the British Association at Leicester. In an editorial article in a leading daily paper, on " When Science Speaks," reference is made to the misgiving, voiced by some of the older scientists on modern tendencies and it goes on to express the following opinion. " When scientists themselves begin to misunderstand one another, however, or to confess that they find some of their colleagues wholly unintelligible, it appears to be time that something was done. It would be useless to call them in to help in reorganizing the world, if every time they opened their mouths, they poured forth nothing but a flood of mystifying sounds."

There is much in the above criticism that can be correctly applied to the modern teaching of science in regard to vitamins, and their application to practical medical problems. A short time ago in a British Medical Association lecture, the recommendation was actually made that the chief medical need of the country was the manufacture of large amounts of vitamin A and D in " tabloid " form. For the reasons to be shortly stated, this teaching is erroneous and seriously calculated to arrest progress. The discovery of vitamins A and D centres round the subject of milk. A brief reference to this is therefore advisable.

Vitamins A and D in Milk.—In 1910 and succeeding years some American investigators notably Osborne, Mendel, M'Collum and Davis, experimenting with young rats fed on a basal diet regarded as of complete chemical composition, proved that milk supplied some special substance essential to life. Their researches suggested that the special value lay in the particular fat and protein of the milk, and their results led them to classify fats into two groups, viz., good fats, such as butter, egg fat, and cod liver oil, and bad fats, *e.g.* lard, almond oil, and olive oil, these having no restorative influence on the growth and nutrition of young rats. A more complete demonstration of the special value of milk on the growth and nutrition of young rats, fed on a basal diet, which, according to accepted standards contained all the proteins, fats, carbohydrates, and salts necessary, was given by Hopkins in 1912. Hopkins showed that young rats fed on an experimental diet which satisfied physiological requirements in respect to chemical composition and energy value, failed to grow and declined in weight, whereas experimental animals fed on the same diet to which a fractional amount of milk was added, grew normally. Hopkins termed the unknown substance in the milk an " accessory food factor." It was for a time believed that this accessory food factor was of the nature of an organic base, or *amine*, and the term vitamine was applied. This view was subsequently found to be incorrect, the terminal E was dropped and the word vitamin retained.

Later investigations showed that vitamin D or, to be more exact, a chemical substance having definite anti-rachitic properties in the feeding of rats, could be made by the application of ultra violet rays to a natural fat (sterol), and vitamin D, as now commercially prepared is an irradiated ergosterol preparation, of which there are many preparations in the market. The physiological activity of vitamin D is determined by an official body—The Pharmaceutical Society of London—by biological tests. These take the form of feeding young rats on a known defective dietary, observing the defects produced on their growth and bony development (by X-rays, etc.) and observing the rate of recovery induced by the " vitamin " preparation. Commercial preparations of vitamin A similarly exist, the chief source of preparation being carrots. The efficacy of this vitamin preparation is similarly tested by biological means, and other tests assumed to be reliable. In the past ten years, many vitamin preparations have come and gone. In the same period, opinions among vitamin researchers have changed as to the function of the two vitamins and as to the nature of the relationship between them. For a time vitamin A was supposed to be concerned mainly with controlling growth, vitamin D being regarded as an antirachitic factor, regulating in some unknown way the action of calcium and phosphorus in the tissues. Latterly it has been assumed that vitamin A is an anti-infective factor, concerned in protection from catarrh, and the differentiation between the two vitamins is now regarded as much less precise than was formerly assumed. More recently the view that vitamin A is an anti-infective factor has been abandoned. Vitamins A and D are normal constituents of good milk. Since the discovery of the vitamins, modern research has established the fact that milk from grass-fed cows is richer in vitamins than milk from stall-fed animals. This confirms the long established views of practical men as to the varying quality of milks, and the greater nutritive value of milk obtained from animals housed and fed under natural conditions of fresh air, sunshine and good food.

Reference has already been made to the present chaotic condition of the subject of vitamins from the practical point of view. The grounds for this assertion will now be shortly stated. This communication is intended to be primarily critical of present authoritatively accepted opinion in regard to the vitamins and their relation to milk, and only to a lesser degree constructive in nature. It will suffice if I refer to three recent authoritative pronouncements which are quoted to illustrate the present chaos. The subject has recently been discussed: (1) in an admirable Bulletin from the Hannah Dairy Research Institute on "The Nutritive Properties of Milk in relation to Pasteurisation—a Review of Existing Knowledge," by J. D. Stirling, B.Sc., Ph.D. and J. H. Blackwood, B.Sc., Ph.D. (1933); (2) at this year's meeting of the British Medical Association in a communication on "The Significance of Vitamins in Practical Experience," by Leslie Harris, D.Sc., Ph.D., of the Nutrition Laboratory, Cambridge; and (3) in the recent annual report of Sir George Newman, Chief Medical Officer of the Ministry of Health. The relevant statements in these reports are as follows:

In Part II of the excellent Bulletin published by The Hannah Dairy Research Institute—in the chapter on "The Effect of Pasteurisation on Accessory Milk Constituents"—the following statements appear:

(*a*) "Modern practice is tending towards less dependence on milk as a source of vitamins during infancy, and towards the safeguard of supplementing milk diets *with concentrated vitamin preparations of known potency*." (The italics are mine.)

(*b*) In relation to absence of vitamin A in the dietary. "The growth failure is most marked and the growth promoting power of a foodstuff is taken under *strictly controlled* conditions as the criterion in the biological assay of its vitamin A." (Again the italics are mine.)

(*c*) "Crawford, Golding, Perry, and Wilson (1930) have shown that vitamin D, like vitamin A, is associated wholly with the fat of milk."

(*d*) "With regard to the prevalence of bad teeth the recent investigations by Mellanby (1918-32) have shown these dental conditions to be in alignment with rickets," and

(*e*) "The vitamin B complex has been split into so many different factors that it would be impossible to attempt any distinction in this survey other than that between the anti-neuritic factor B, and the anti-pellagra factor B_2."

The above may confidently be stated to represent accurately the present teaching on the subject, but it is noteworthy that a largely increasing number of medical practitioners are becoming, to say the least, a little incredulous. From my point of view it will not stand critical analysis—for this reason. A very large part of the work on which the efficiency of the vitamin preparations was determined, and the subsequent commercial vitamins prepared was based on biological tests, which have since been proved to be fallacious. Writing in 1930, Professor Drummond pointed out, from an investigation into the potency of various cod liver oil preparations in vitamin A, that even if five times the number of animals are employed for a biological test than were used in the official tests, the margin of error is still 100 per cent. *The scientific value of a test of which this can be said is surely nil.* So far as I am aware, this statement of Professor Drummond's has never been contradicted, and indeed it would appear that this discovery has been all but entirely ignored in the literature of the subject. It is right, however, to state that in sequence to his work, the subject of international vitamin standards was recently considered by the Health Organization of the League of Nations, Professor Drummond being a member of this committee. At this conference a new test for the biological efficiency of vitamin A was resolved on. In regard to this new test I am under the impression that within a few months several of the manufacturers unhesitatingly came to the conclusion that the new test was less satisfactory than the old, and reverted to the use of the older method.

It may confidently be asserted that the assumption of the *complete* association of vitamin D with fat (as stated at *c* above) is erroneous. The claim is effectively disproved by reference to known facts as to the curative influence of irradiated milk in the treatment of rickets. The striking value of properly irradiated milk in promoting rapid healing of the bony and other changes in rickets has been firmly established by numerous American and German investigators, and, in this country, I have recorded not a few cases where a speedy cure was effected by its means in patients who had been previously under careful treatment by one or other of the numerous vitamin D preparations in common use, without material benefit. I have, moreover, gone a step further, and have shown that separated milk, containing not more than ·1 per cent. of fat still retains in a high degree this anti-rachitic property. My conclusion on this point has not, so far as I am aware, been either confirmed or opposed, so that it may not be regarded as final. Its confirmation would involve a radical change in much of the present teaching regarding this "vitamin."

With regard to *d*—the intimate relationship between dental disorders, vitamin D and rickets is based on Mellanby's teaching. Serious objection has to be made to this teaching. On the practical side there would appear to be an overwhelming majority of practising dentists who dissent from it, and on the scientific side there appears to be conclusive evidence against it. This was provided by an extensive series of investigations carried out in the Physiological Laboratory of Edinburgh University by the author and numerous collaborators some years before the "vitamins" were discovered in 1912. The dental side of this research was carried out by two highly skilled dental microscopists—the late G. W. Watson, L.D.S., then President of the Edinburgh Odontological Society, and J. H. Gibbs, F.R.C.S. In their very detailed examination of the teeth of a large number of young rats, very gravely affected with advanced rachitic changes of the whole bony skeleton, they found no macroscopic or microscopic variation of note from the normal. The significance of this finding appears to have been overlooked. It is of interest to note that when on one occasion the attention of an eminent vitamin researcher was drawn to it, the only suggestion offered was the existence of some fallacy in the observation! It should be noted that while expressly differing from the accepted teaching as to the very intimate relationship between vitamin D and rickets, the writer fully accepts as correct the widely accepted teaching, based on long-established clinical observation, that faulty nutrition in early years, and in the ante-natal period, is the most important etiological factor in inducing caries and allied dental disorders in early life.

The statement *e* regarding vitamin B is wholly accurate. It is submitted to illustrate the complexity with which, as a result of the high degree of modern specialization in research, the subject is now enveloped.

In the light of the foregoing a brief reference to the opinions expressed in the recent communication to the British Medical Association at its annual meeting given by Leslie Harris, D.Sc., Ph.D., of the Nutrition Laboratory, Cambridge, is instructive. Two extracts will suffice :

(*a*) "For curative purposes, irradiated ergosterol is undoubtedly the method of choice. It can easily be given at a sufficiently high and *precisely standardized level.*" (The italics are mine.)

(*b*) "Coward (Pharmaceutical Society Expert) found that taking the average for the different specimens of irradiated milk examined, no less than 5½ pints would be needed to provide the equivalent of two teaspoonfuls of cod liver oil." This conclusion, drawn from laboratory observations, has been found to be in opposition to the teaching of clinical experience.

In regard to the first, reference has already been made to the great limitations to the value of official biological tests as a guide to the value of vitamins in practical medicine, and in reply to the second, reference may be made to my published results which showed that severe rickets in children could be quickly cured by the administration of half a pint of irradiated milk daily for a few weeks, this actually occurring in a series of four cases under very special controlled conditions, where the children had been under treatment unsuccessfully with irradiated ergosterol and other vitamin D preparations, including cod liver oil, for 6 to 8 weeks previously. It is noteworthy that according to official laboratory test the amount of vitamin D in the milk used in the above experiment was reported to be fractional in comparison with the amount present in laboratory prepared vitamin D preparations.

In his recently issued annual report Sir George Newman expresses views and recommendations on food and milk to which reference here is relevant. With his general statement that " our scientific knowledge stands far ahead of our practical " most people will agree. This does not, however, hold good in relation to vitamins, in regard to which the teaching of the scientists has been much too readily translated into practice. Sir George himself recognises this, as he refers to the present " risk to health and debasement of the nutritive value of food " which may be associated with " ' fortification ' of foods by artificially added vitamins." In regard to the pasteurisation of milk he is, in my view, on much less sure ground when he alleges that " the one prompt and safe method of protection is pasteurisation." Is he here not a little contradictory ? My experience and also the review of the available literature leads me to the conclusion that milk is definitely debased by pasteurisation, at least as much as flour is debased by bleaching, which Sir George admits. Pasteurisation should, so far as possible, be avoided as only a policy of despair. Can anyone submit definite evidence of scientific or legal value that white flour is a debased product ? I know of none. Many years ago the assistance of the writer and of the late Professor Benjamin Moore of Liverpool was sought in an important action taken by the authorities in Lanarkshire to prove that the bleaching of flour was prejudicial, and should be made illegal, but in vain. Sir George, however, is none the less right in his contention that the bleaching of flour debases its nutritive value. In regard to milk, it seems clear, as is only natural, that he has accepted as correct, teaching of the laboratory experts on vitamins which will not stand close critical study. His remedy, moreover, leaves out of account the question of milk infected with bacillus coli, a contaminating organism which according to present regulations must not be present in the higher grade milks. It is not sufficiently known that the methods of pasteurisation in common use do not by any means effectively destroy this organism and it would appear that this fact has been overlooked by the exponents of compulsory pasteurisation. In the writer's experience, a considerable proportion of the pasteurised milk in daily use shows the presence of B. coli in all three dilutions. It would be of interest to know how many of the large teaching hospitals in the country are supplied with milk of the Grade A T.T. standard. It is one of the anomalies of medical education to-day that young graduates of medicine know less about the presence of B. coli in milk than the dairy farmers concerned in the production of graded milk.

Medical Opinion on the Clinical Value of Vitamin Preparations.—It is not too much to say that in recent years increasing doubt has arisen in the minds of a large number of thoughtful practitioners as to the efficacy of numerous artificially prepared vitamins for "curing" the various disorders for which they are recommended on the strength of laboratory researches. In the past two years or more, I have on numerous occasions tested the point by requesting the opinion of a large number of post-graduate medical men, and in general the opinion expressed is one of considerable doubt. At a medical meeting in Manchester a few months ago, when the subject was under review by the writer, a prominent physician in medical control of a hospital with 800 beds was more emphatic in his conclusion ; he had formed the opinion that they were of little or no practical value. Relevant to the chaotic condition of opinions brought out in the foregoing, it is of interest to note that clinical teachers of medicine appear to be now tending to query the presently accepted teaching of the laboratory. In a communication given at the recent annual meeting of the British Medical Association on "Vitamin B in the Treatment of Anæmia" by a Professor of Medicine, the speaker opened his remarks with the following highly informative statement. He would prefer, he said, to substitute for vitamin B in his title the words "Autolysed Yeast," as it had been proved by recently published work that the therapeutic factor in autolysed yeast or marmite was not "vitamin B." Another example of striking contradiction! It is unnecessary to cite any further examples of the reaction that is taking place in favour of independent thinking on the part of thoughtful clinicians.

Author's Views and Recommendations.—In my view the secrets of what we at present term "vitamins" will, when they are revealed, support the opinions of those scientists who attach importance to what is termed the vitalistic, as opposed to the materialistic, conception of life. It is my view that "vitamins" are essentially the products of radiant energy, and the data which have led me to this view may be very shortly summarised.

(1) A lengthy investigation on nutrition (1902-1906), referred

to in the text, yielded many striking graphic curves, indicating the remarkable recuperative power of milk in animals fed on various abnormal dietaries. The explanation then given of the results assumed the operation of some unknown vital factor.

(2) The remarkable advances made in the past twenty-five years in our knowledge of physics appear to throw light on the nature of this vital factor. The significance of the new knowledge gained as to the very intimate relationship between *matter*, *radiation* and *energy*, and of the *Sun* as the source of all energy, has not yet been adequately considered, in its relation to the problems of practical medicine, and more especially nutrition problems.

(3) Vitamins in nature exist only in the vegetable kingdom, and the energy value of foods is in a very great degree debased by modern methods of preservation and preparation. It has, in the writer's view, been insufficiently realised that the special value of Hopkin's classical researches which revealed the existence of "accessory food factors" was the conclusive evidence his research gave that all previously accepted teaching as to the "energy value of food," based as that had been on skilled chemical investigations in the laboratory, was erroneous.

(4) Some suggestive confirmation of the writer's view is supplied by established work of horticulturists, the existence and significance of which appear to have been overlooked by vitamin workers. It has been shown that carrots (and other vegetables) fail to grow and fail to produce vitamins, when grown under conditions in which the blue violet rays of the solar spectrum are withheld by appropriate glass screening. Carrots, it has already been pointed out, are the main source of commercially prepared vitamin A. Science and common sense alike suggest the superiority of good fresh carrots as the safest and best source of this vitamin.

(5) A few years ago at my request, Dr Ludlam of the Chemistry Department of Edinburgh University determined the spectrum of "Adrenalin," the active principle or hormone in the suprarenal gland. This revealed a spectrum showing a main band in the region of wave-lengths 2,800. The known fact that irradiated Ergosterol (or vitamin D) is prepared by radiation of a sterol by wave-lengths in the same part of the spectrum impressed the writer as of great interest and possible significance. This fact appeared to confirm my conclusion that in the search for the truth about vitamins, we have to look at least as much to the biophysicist as to the biochemist. *To an important extent the search for real truth must begin afresh.*

(6) The known facts already given about the therapeutic value of irradiated milk have to be brought into line with the above data. And in this connection one should keep in mind that the modern cow has been "educated" to give a supply of milk vastly above the natural supply. It is possible that in the process the energy value of the milk may have been somewhat reduced.

It is of interest to observe that this conception of the nature of vitamins has attracted the attention of at least some vitamin workers. This is revealed in a statement which appears in Stirling's and Blackwood's admirable Bulletin to the effect that " cod liver oil, in the amount used, was less effective as a means of supplying radiant energy (vitamin D) than either irradiated olive oil, or irradiated milk."

I am wholeheartedly in agreement with the opinion recently expressed in a leading article in the *British Medical Journal* (1932), adverse to the proposal for the compulsory pasteurisation of all milk except certified milk, on the ground that "to do so, would, in our opinion, stultify the elaborate care with which graded milk is produced." While I fully recognise the controversial aspects of the scientific and practical problems involved, my view is that the policy of compulsory pasteurisation is inherently unsound and retrograde.

REFERENCES

1. A useful summary of recent literature on the Pasteurised *versus* Raw Milk Question is given in *Bulletin No. 5 of the Hannah Dairy Research Institute* (1933). Stirling & Blackwood.

2. "Appendix to Food and Feeding in Health and Disease, 2nd edit. 1913," giving an account of some of the earlier researches referred to in the present paper. Chalmers Watson and eight Collaborators.

3. "Radiation in relation to Human and Animal Nutrition, with a theory as to the nature of Vitamins." Chalmers Watson, *Proc. Roy. Soc. Med.* (Section of Electro Therapeutics) 1931.

CHEMISTRY AND AGRICULTURE[1]

ALEXANDER LAUDER, D.Sc.

Edinburgh and East of Scotland College of Agriculture

WHEN the Association last met in Leicester in 1907, agriculture was represented by two papers presented to the Chemical Section. One was a discussion on the qualities of wheat and flour, dealing particularly with the strength of flour, and the second on the " Production of Acid or Alkaline Reactions in the Soil by Manures," by Mr A. D. Hall. A glance at the recent programmes of this Section will give some idea of the developments which have taken place since we last visited Leicester.

At the meeting of the Association in Swansea in 1880, Sir J. H. Gilbert was President of the Chemical Section, and devoted his address to the application of chemistry to agriculture.

Gilbert devoted about a third of his address to an historical introduction and to a detailed description of the new views brought forward by Liebig. He then went on to discuss how far Liebig's views had been modified in the course of time, and to state the conclusions which had been arrived at by recent work on plant and animal nutrition.

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[1] Substance of Presidential Address delivered to the Agriculture Section of the British Association at Leicester, September 1933.

As regards plant nutrition, the main problems were the sources of carbon and nitrogen, and the views then expressed by Gilbert are still held without serious modification at the present day.

In the later part of his address, he dealt with two questions which were then exciting much attention, viz. the origin of muscular power and the sources of fat in the animal body.

The conclusion arrived at was that the fat of the herbivora is largely produced from the carbohydrates of their ration. As regards the origin of muscular power, he concluded after a careful review, "that all the experimental evidence at command tended to show that by an increased exercise of muscular power, there was, with increased requirement for respirable material, probably no increased production and voidance of urea, unless owing to excess of nitrogenous matter in the food or of a deficiency of non-nitrogenous matter, the nitrogenous constituents of the body were drawn upon, in an abnormal degree, for the supply of respirable material."

He concluded his address by stating that "while much remained to be done both in chemistry and physiology as regards the above problems, yet I think we may congratulate ourselves on the re-establishment of the true faith in regard to them, so far at least as the most important practical points are concerned."

A great deal of the investigations during the past half-century have been concerned with the more accurate and detailed working out of the ideas discussed by Gilbert and his contemporaries and the explanation of many points in agricultural practice which had been evolved by centuries of experience by farmers, and while nothing spectacular in the way of change may have resulted, the cumulative effect of the more accurate knowledge about soils, fertilizers, crops and nutrition has undoubtedly been important.

In addition, several discoveries of fundamental importance have been made : the synthetic manufacture of ammonia and nitrates ; the effects of vitamins in animal nutrition ; the theory of base exchange in soils ; and the development of bacteriology, to mention some of the more outstanding only.

Some of these, although they might be described as advances purely from the scientific side, have yet had practical applications of the highest importance. The theory of base exchange in soils,[1] which may be said to have originated in this country with the early work of Way in the fifties of last century and is associated in modern times with the names of Gedroiz, Hissink and Wiegner, has provided an explanation of absorption and exchange phenomena and of soil acidity, and has been successfully applied to the reclamation of alkali soils in Hungary (Von Sigmond) and the Western States of America, as well as in the treatment of land recovered from the sea.

Amongst other notable advances which have had a practical application, may also be mentioned the use of sulphur for reducing fungoid attacks on crops and for reducing alkalinity in soils, particularly soils used for growing potatoes, and the study of the functions of elements which occur only in minute quantities in plants, *e.g.* copper, manganese and boron. The application of modern statistical methods to the interpretation of field experiments and of biological experiments generally, has led to a more accurate appreciation of the experimental errors involved, and of the significance attached to any result.

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[1] *Scottish Jour. of Agric.*, vol. ix. (1926), p. 25.

Since the last meeting in Leicester, very real advances have been made in our knowledge of the chemistry of the proteins, carbohydrates and fats, and of enzymes ; this has led necessarily to a clearer appreciation of the processes concerned in the synthesis of plant products and of animal metabolism.

Among the major problems awaiting solution are the methods by which plants take up their nutrients and the further development of biochemical methods generally.

The Soil.—The study of the soil may be approached from two points of view. In the first of these, it is regarded as the seat of certain chemical, physical and biological processes which are investigated entirely from the scientific point of view without any reference to agriculture. This has been the method of attack of the Russian school in particular, and the supposition is that when a sufficient body of knowledge has been accumulated in this way, the consideration of the facts obtained may result in practical applications of value to the agriculturist ; it should be emphasized, however, that the approach in the first instance is purely scientific. The interesting volume published a few months ago by Prof. G. W. Robinson of Bangor, gives a clear exposition of the methods of this school and of the results which have, so far, been obtained. The other method has been to study the soil as the medium of plant growth, to investigate practical problems as they arise and to have as its definite aim the giving of advice to those engaged in agriculture as to improving their methods of tillage and crop production. It is obvious, of course, that no definite division can be made between the two methods of approach, as is shown by the history of recent developments. In this country, while the former method has been by no means neglected, as witness the large amount of research work carried on at Rothamsted and to a lesser degree elsewhere, it is the latter method which has been in the main officially supported and subsidized by successive governments.

Amongst the scientific methods which have emerged and received considerable prominence and support in recent years is the modern method of soil classification. This, while belonging to the scientific method of investigation, also seeks to justify its existence by the claim that it is of immediate importance to the farmer. The method was first developed in Russia, and at the International Soil Congress held at Rome in 1924, it was agreed to construct a soil map of

Europe. The *General Map of the Soils of Europe*, under the editorship of Prof. Stremme, Danzig, was published in 1927. The English text, translated by Dr W. G. Ogg, of the Macaulay Institute for Soil Research, Aberdeen, was published in 1929 with the aid of a grant from the Department of Agriculture for Scotland. The first edition of the map is on the scale of 1 : 10,000,000, and preparations for a second edition are in progress.

The idea of a soil map of Europe is an ambitious one and the conception is not without its attractiveness. In the present state of our knowledge, however, it appears to many that the plan is possibly premature and that there is a great element of unreality in the results. It is only fair to the editors to say that they fully realize the difficulties of carrying out a survey of this extent on a uniform basis, and admit that the results are imperfect and will require to be modified in various ways. It seems fairly clear, however, that the difficulties of making such a map have been seriously underrated. Few workers in Europe have any extensive knowledge of soils outside their own countries, with the inevitable confusion as regards classification and nomenclature. At home, our soil workers have to be content with spending a few weeks in the field each summer. It is evident, therefore, that the difficulties are great and that the rate of progress must be slow. At the same time, the meetings of workers from different countries at the International Soil Conferences with the resultant exchange of ideas and experiences must be valuable in the development of the subject.

In passing, it may be noted that there appears to be a certain reluctance on the part of the advocates of these methods, to ascertain by means of carefully conducted field experiments, whether some of the differences they are mapping are really significant and whether some of the finer differences which they map, between soils within the same type, have any reality and make any appreciable difference in agricultural practice.

As regards the utility of soil surveys generally, a reasonable case can be made out for the benefits which are likely to follow a careful survey of a new country which is just being developed. The difficulty there, is to provide the staff and funds, so that the survey work is kept ahead of the development.

In a country like this, on the other hand, there is considerable doubt on the part of many, as to whether the benefits which are supposed to follow such a survey will ever be realized. The question of suitable crop distribution and association is well established as the result of generations of experience and is not likely to be seriously altered as the result of such an investigation. It is claimed that a soil survey on the scale of 1 inch to the mile would be of great importance in connection with manuring and in the interpretation of the results obtained by the various methods of estimating the available plant nutrients in the soil. Before undertaking a survey of such magnitude, it should be pointed out that such a claim would require to be based on the results of a wider series of accurate field trials than are available at present. At the same time, the importance of survey methods from the purely scientific point of view and also in connection with land reclamation problems should not be overlooked.

What the farmer wishes to know about his soil is whether it is adequately supplied with nitrogen, phosphates and potash, and whether there is sufficient lime present to give a satisfactory soil reaction. These are reasonable questions, but it must be admitted that in the past the task of the agricultural chemist who had to attempt to answer them was by no means easy.

With regard to nitrogen, no method exists by which we can judge the requirements of a soil as regards this element; the fact that most soils respond to dressings of soluble nitrogenous fertilizers is about as far as we can go in the way of prediction.

On the other hand, the lime requirement of a soil can now be given with reasonable accuracy by routine methods which are suitable for use on a large scale. The question as to whether the dressing of lime which is theoretically desirable can be recommended, is generally an economic rather than a chemical one.

To determine what the requirements of a soil are with regard to available phosphates and potassium is a more difficult matter. The most that can be aimed at, at present, is to be able to say whether the soil is well supplied or moderately supplied with these constituents, or is deficient in them.

The difficulties of discriminating between the available and non-available constituents in a soil are obvious. In the first place, the way in which plants take up their nutrients from the soil is still a matter of controversy, and the fact that the soil is a heterogeneous and ever-changing system of extreme complexity greatly increases the difficulties. The chemical methods generally employed involve the extraction of the soil with water or some dilute solvent and the estimation of the phosphates and potassium which come into solution under standard conditions. When the results can be interpretated in the light of field experiments or experience, they are a very useful guide in advisory work. The fact that the method is an empirical one is a great drawback, but the more serious objection is that the results give a measure of the condition of a soil at a particular time only and obviously cannot apply to its condition at different times throughout the year. There is probably no hard and fast line between the "non-available" and the "available" constituents, the one set gradually merging into the other.

These fundamental difficulties have suggested the idea of making use of the plant itself as an index to the available plant nutrients in the soil. Much work from this point of view has been carried out and two methods based on these principles have been in use on the Continent for several years. These are the well-known methods of Mitscherlich and Neubauer, which have been very ably and critically reviewed by Dr R. Stewart in a recent publication of the Imperial Bureau of Soil Science (*Technical Communication* No. 25, 1932).[1]

One general difficulty which applies to both methods is that they can be carried out only at institutes specially equipped for the purpose. The Mitscherlich method requires a whole season to carry out the test, while the Neubauer requires much supervision and extreme accuracy in the analytical work. Attempts have, therefore, been made to devise simpler biochemical methods suitable for the ordinary laboratory use ; of these, two are of special interest.

The Azotobacter Method.—The *Azotobacter chroococcum* is a well-known soil micro-organism which has the power of fixing soil nitrogen, and its use as a method for testing soils was first worked out in Denmark, where it is still employed. The organism is very sensitive to acid conditions, and this was used as the basis of a method for measuring the " lime requirements " of a soil. This method has been superseded by the more convenient and more accurate physico-chemical methods now employed. In addition to requiring a non-acid medium, the rate of growth of the organism depends also on the supply of phosphates, and later the method was adopted for the estimation of the available phosphates in the soil. The defect of the method is that there is no accurate means of estimating the development of the bacteria and that the results are therefore only qualitative in character.

The Aspergillus Method.—The principle of this method is the same as that described above, but it has the advantage of being more quantitative in character, as it is possible to collect the fungus and weigh it. It was found that under standard conditions the growth of *Aspergillus niger* is proportional to the amounts of available potash and phosphates in the soil.

The mould is grown in a suspension of the soil in a culture solution containing all the constituents necessary for growth except the one being tested for, and the results of a large number of experiments have shown that the standard error is of the order 4 per cent.

The method has been worked out by Prof. Niklas and his colleagues at the Agricultural Research Station at Weihenstephen, near Munich, and has also been subjected to a critical examination by Dr A. M. Smith, Edinburgh, who has tested the method with a variety of Scottish soils, as well as investigating the effect of different sources of nitrogen on the process.[2]

The results obtained by this method have been compared with those obtained by Neubauer's method, and have shown on the whole very good agreement, especially for potassium. The richer the soil as estimated by the Neubauer method, the greater the growth of *Aspergillus*. For phosphates the agreement between the two methods is very good as far as poor soils are concerned, but is only moderately good for the intermediate or richer soils ; one difficulty is that the absorption of phosphates by the fungus is not constant for different types of phosphates.

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[1] See also *Scot. Jour. of Agric.*, vol xii., No. 3, pp. 251-262.

[2] *Ibid.*, vol. xv., No. 3, pp. 262-271.

The whole question of available plant food is necessarily bound up with the complex relationships which exist between plant and soil, and it is unlikely that any simple or single method will be devised to overcome the inherent difficulties of the problem and be generally applicable to different sets of conditions. The admitted lack of agreement obtained with the various methods at present in use is undoubtedly due, to a large extent, to the variety of factors involved, as well as to the fundamental objections which may be raised to any one method. We are still very ignorant of the process of assimilation by the growing plant, and until we have more information on this subject, methods of estimating availability must continue to be largely empirical and the results merely first approximations.

The usual method of approach to the problem has been to study the effect of the soil or plant medium on the plant. In Edinburgh, attention has in recent years been directed in the opposite direction —namely, to a study of the effect of the plant on the soil. The alterations to be observed are, of course, small, but by applying methods which might almost be described as analogous to modern micro-methods of analysis, measurable changes can be followed with considerable accuracy. The results which have been obtained are interesting and sometimes rather unexpected, and although it is scarcely to be supposed that they will furnish a complete picture of the relationship between soil and plants, one feels that any contribution to the subject from a new angle may be of value in the study of such a complex problem.

Fertilizers.—Turning next to the progress which has been made in the manufacture and use of fertilizers since the time of Gilbert's address, there are one or two notable dates and achievements to be mentioned.

First in the order of time, is the discovery of the value of basic slag as a fertilizer. The earliest experiments in this country were carried out in England by Wrightson and Munro in 1885, and by A. P. Aitken in Scotland about the same time ; a year or two later J. J. Dobbie carried out the first experiments with the slag in North Wales.

The now classic experiments laid down by Prof. Somerville in 1896 and carried on and developed by his successors, Sir Thomas Middleton and Prof. Gilchrist, have demonstrated the value of this addition to phosphatic fertilizers and show as the result of twenty-five years' experiments that basic slag is, for certain types of soil, even more valuable than superphosphate. Since slag is a by-product of steel-making, the composition varies with changes in the methods of making steel. About ten years ago, therefore, the Ministry of Agriculture and Fisheries set up a permanent committee on basic slag "to consider the development and improvement of the manufacture of basic slag and the extension of its use." This committee has produced a valuable series of reports, the last (tenth) report being published in September 1932. The work of the committee has been, in general, "to make a detailed study of the agricultural values of the slags now available to farmers and the chemical means by which these values can be expressed." The figures obtained for the recovery of phosphoric acid were interesting. For two years, the recovery of phosphoric acid added, were: superphosphate, 12 per cent.; high soluble slag, 9 per cent.; mineral phosphate, 4 per cent.; and low-soluble slag, 2 per cent.

Superphosphate.—Improved methods of manufacture and better sources of raw material have led to a progressive improvement in the quality of this fertilizer. Formerly, superphosphate was considered an acid manure and its continued use was supposed to deplete the soil of lime and to increase its acidity. A large amount of experimental work has been carried out in recent years, and the result is to show conclusively that the objections to the use of the so-called physiologically acid manures have been the result of misconceptions or possibly even misrepresentations. The use of superphosphate does not generally increase the acidity of the soil.

Nitrogenous Fertilizers.—In the year 1898, the President of the Association, Sir William Crookes, devoted his address to showing that if the rate of increase then assumed of the world's population was correct, the world would be faced with a wheat famine in the not far distant future. He pointed out also the necessity, if we were to increase the production of wheat, of the increased use of ammonium salts and nitrates as fertilizers. As regards nitrogenous fertilizers, he showed that we were living on our capital of combined nitrogen compounds and that there was also the danger of a nitrogen famine to be faced. The remedy he suggested was to devise methods for "fixing" or bringing into combination the nitrogen of the atmosphere, and he actually sketched methods and estimated costs of effecting this combination by electrical means. As far back as 1784, Cavendish had shown that oxygen and nitrogen could be made to combine under the influence of the electric spark. Many years were to elapse, however, before a practical commercial method was evolved. The earlier methods were electrical in character and were developed in Norway and Italy, where cheap supplies of electrical energy were available. These methods have been more or less superseded, and ammonia is now manufactured by a synthetic method on an enormous scale at the works of the Imperial Chemical Industries, Ltd., at Billingham. The method used is a modification of the Haber-Bosch process. The practical difficulties which had to be faced were great; of these I need only mention the problem of working at pressures of over 200 atmospheres—*i.e.*, over 3,000 lb. per square inch—and at an elevated temperature, to enable you to realise some of the difficulties which had to be overcome. The successful development of the method is certainly one of the greatest triumphs of chemistry and engineering in modern times. By this process, which incidentally dispenses with the use of sulphuric acid, sulphate of ammonia can now be prepared more cheaply than from gas liquor where the ammonia is obtained as a by-product.

By the oxidation of ammonia to nitric acid by means of a suitable catalyst, ammonium nitrate can be prepared, and by mixing this with calcium carbonate, a valuable fertilizer, known commercially as " nitro-chalk," is manufactured.

Concentrated Complete Fertilizers.—One of the most interesting developments of the synthetic ammonia industry has been the manufacture of concentrated complete fertilizers containing nitrogen, phosphates and potash, in suitable proportions and all soluble in water. The basis of these fertilizers is a mono-ammonium phosphate which is made by subjecting finely ground rock phosphate to the action of a mixture of sulphuric acid and ammonium sulphate. This gives directly a solution of mono-ammonium phosphate containing a little ammonium sulphate and calcium sulphate is precipitated. The mono-ammonium phosphate contains 12·2 per cent. nitrogen and 61·7 per cent. phosphoric acid and is thus a highly concentrated fertilizer. By mixing this with ammonium sulphate and a suitable potash salt, a wide range of fertilizers can be obtained. Roughly, one ton of such fertilizers supplies as much plant food as two tons of the ordinary mixed fertilizer of similar composition. They possess the obvious advantage of reducing freight and handling charges and cost of distribution to the land ; they are granular in texture and very easy to sow, and they can be stored without risk of deterioration ; further, the constituents are all soluble in water.

Another point claimed in their favour is that they contain little except the three fertilizers, nitrogen, phosphates and potash, while the ordinary fertilizers contain appreciable, and in some cases large, amounts of calcium, sulphur, and other elements. It is possible that in some soils the absence of the additional substances might be a disadvantage, and a careful comparison of the new fertilizers with the old mixed fertilizers will be necessary to show that no disadvantage attends the use of the new compounds over a number of years. Accurate field experiments on a wide variety of soils were carried out in this country in 1930 to compare the relative effects of the concentrated complete fertilizers and of mixtures of sulphate of ammonia, superphosphate and potash, giving the same amounts of nitrogen, phosphates and potash. With the three crops examined (oats, potatoes and sugar beet), the concentrated fertilizers gave the same average increases in yield as the equivalent ordinary mixtures. At certain centres, however, the concentrated fertilizers gave better results and at others a poorer yield than the ordinary mixtures. The work is being continued.

It is obvious that if the concentrated fertilizers were used continuously over a number of years, increased attention would require to be given to liming.

Biochemistry.—The earlier workers in organic chemistry were much occupied with the study of the substances which occur naturally in plants and animals; but later the trend of investigation, particularly in this country, shifted to the study of more theoretical questions, *e.g.*, the investigation of radicles, the theory of substitution and types and the theory of structure. These investigations gave a great impetus to organic synthesis and the number of known carbon compounds increased rapidly. Most of the substances investigated, *e.g.*, the many products obtained from coal tar, had no connection with animal or plant life, and organic chemistry became much more the chemistry of the carbon compounds than that of living organisms. Until the beginning of the present century, the interest in the chemistry of natural products steadily declined, and it is only since then that the development of Biochemistry, as we know it now, may be said to have taken place.

It is obvious that the investigation of the chemical changes which take place in a living cell presents difficulties of a very high order. The reactions involved take place in very dilute solution; the intermediate bodies formed have a very brief existence, being rapidly changed into some further product; so that, while we may know the initial substances involved and the final product of the reaction, there may be little known as to the various stages in the formation of the final product.

While there have been great advances in our knowledge of the structure of many of the substances found in plants and animals, we still know relatively little about the processes by which they are formed. The various stages in the fundamental process of photosynthesis have not yet been worked out, although plausible suggestions as to what takes place have not been wanting. We are ignorant of the stages by which amino-acids in plants are formed from nitrates and carbohydrates and little is known of the methods by which carbohydrates are changed into fats and *vice versa*. In the same way, while we have a considerable amount of knowledge as to how the proteins, fat and carbohydrates are broken down in animals, little information is as yet available as to how similar changes are brought about in plants.

Great advances in our knowledge of the structure of the carbohydrates have also been made. The work of Purdie and Irvine at St Andrews and of Haworth and his school at Birmingham, of Staudinger, Zechmister and Mark in Germany and of other workers in the United States has been particularly important in elucidating the structure of these complex bodies.

Vitamins.—A discovery which will always be associated with the name of the distinguished President of the Association this year (Sir Frederick Gowland Hopkins), is the importance in nutrition of the accessory food substances now known as vitamins. As far back as 1881, it was noticed that milk cannot be replaced by an artificial mixture of its chief constituents. In 1905, Pekelharing, of the

University of Utrecht, made the striking claim that there is an unknown but essential substance in milk and other foods which is essential to nutrition. This work was overlooked, and it was not until the publication of Hopkins' work in 1912 that general interest was attracted to the subject. The progress since then in the study of these bodies is most striking. One of the most remarkable facts which have resulted from these investigations is the large number of substances of the vitamin type required for the proper nutrition of the higher animals, the number being stated to be at least nine. Ordinarily, five different vitamins are recognized, designated A, B, C, D and E. Vitamin B is now subdivided into no less than five substances, commonly referred to as the Vitamin B complex.

The discovery of vitamins has undoubtedly thrown much light on many of the difficult problems of nutrition and disease, and there can be no doubt that, as our knowledge of these substances increases, more and more use will be made of them in feeding. Already some notable advances have been made. There is a close connection between the yellow coloured pigment carotene and Vitamin A. Milk and butter produced in the summer months, when the cows are at pasture, have a yellow colour which is associated with the presence of carotene and of Vitamin A. On the other hand, butter produced from winter milk, when the cows are stall fed, is much whiter in colour and has a much lower content of carotene and Vitamin A. The popular view which associates the yellow colour of milk with "richness" is therefore not at fault, and incidentally the importance of prohibiting the colouring of butter and cheese should be mentioned. The problem was how to provide food with the necessary carotene or Vitamin A content during the winter months. Experiments on the artificial drying of grass carried out at the Agricultural Research Station at Jealotts Hill, Berkshire, have shown that grass can be rapidly dried in a band drier at a temperature of 200° approximately, with scarcely any loss of digestibility or nutritive value and, what is more surprising, with only a small loss of the carotene content. It was also shown that the carotene content and the nitrogen content of pasture herbage were associated, grass of high nitrogen content being rich in carotene, so that by properly balanced manuring, the carotene content of the pasture might be maintained at a higher level. A winter feeding experiment with cows was then arranged and the artificially dried grass was used to replace an equivalent amount of the ordinary food, with the result that the carotene and Vitamin A content of the butter was kept up. This effect was not produced by the addition of ordinary green silage. The importance to the public health of being able to produce in winter butter which, in regard to colour and Vitamin A content, is equal to the butter produced in summer from grass-fed cows, can hardly be over-estimated.

As regards vitamins generally, the most important problems are the differentiation of the different vitamins and the determination of the vitamin requirements of man and the higher animals. By the time this is done, it appears probable that there will be an abundant supply of pure vitamins to compensate for the deficiencies in the ordinary rations.

While talking of nutrition, the part played by the mineral matter of the food must also be mentioned and the necessity for maintaining a correct ratio between the basic and acidic constituents. Much important work has been carried out in this country in recent years by the Rowett Institute and the Animal Nutrition Research Institute at Cambridge on the mineral content of pastures. In his Presidential Address at Bristol in 1930, Prof. Du Toit described the far-reaching results of Theiler's work in South Africa on phosphorus deficiency, and referred also to Aston's work on iron deficiency in New Zealand.

Agricultural Development.—Sufficient has been said of the scientific advances in recent years to indicate the great importance of their application, when possible, to agricultural industry. At one time it was only too apparent that there existed a long lag between scientific discovery and its application in agricultural research, but this has diminished considerably in recent years ; indeed, it may now be said that any new line of work is almost at once turned to account in agricultural investigation.

This agricultural work is undertaken mainly at the new agricultural research institutes, although a considerable amount of work is still carried out at the universities and the agricultural colleges.

The development of these research institutes has been one of the most marked advances connected with agricultural science which have taken place in recent years.

In Scotland alone, for example, institutes have been established within the last few years for research in animal nutrition, in animal diseases, in animal genetics, in plant breeding, in dairying and in soil science, and the progress in England has been equally great.

How are the results of these investigations brought before the farmer and what is his response to them ? How far are they being incorporated into modern agricultural practice ?

It is one of the functions of the agricultural colleges to be the connecting link between the research institutes and the farmer. Advisory services in connection with the colleges now cover the whole country, so that farmers desiring advice have it provided at their own doors and without cost. Mention must also be made of the intelligence services of the Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland and the Ministry of Agriculture for Northern Ireland, whose various publications, journals, bulletins, etc., contain much valuable information.

As to the reaction of the farmer, one is bound to admit that, owing to the inherent disinclination of the older farmers to listen to new ideas, the response is not what we should desire. At the same time, the more intelligent and progressive farmers are fully aware of the value of the advisory work of the colleges and make use of them regularly. The whole attitude of the farmer to the colleges is vastly different from what it was twenty-five or thirty years ago, and the amount of advisory work is increasing year by year.

This much must be admitted, however, that there is still room for improvements in agricultural methods and that much of the farming still requires to be raised to the level of the best practice.

We may state, therefore, with confidence that the difficulties of present-day agriculture are not due to the lack of scientific advice available to the farmer ; indeed, it is even sometimes alleged that the present-day troubles of agriculture are due to scientific research and to an abnormal increase in production.

In a paper contributed to this Section last year at York, Mr E. M. H. Lloyd, the Assistant Secretary of the Empire Marketing Board,[1] quoted figures to show that the world production of food stuffs and raw materials, though it increased rapidly after the set-back due to the war, had not reached, in 1929, the continuation of the pre-war trend. The statistics suggest that world agricultural production is, in fact, less now than it would have been but for the war. " The agricultural crisis is due to the fall in prices ; and this fall of prices is due more to diminution of effective demand through a contraction of consumers' money incomes, than to any exceptional increase of supply."

It is certain, therefore, that the advances in the application of science to agriculture are not the causes of the prevailing agricultural depression throughout the world, but that they are to be sought for in the absence of satisfactory schemes of collective planning, marketing, stability in the value of money and the maintenance of better equilibrium between prices, wages and debts, to quote again from Mr Lloyd.

Whatever opinion may be held as to over- or under-production of agricultural produce in the world as a whole, this much at any rate is clear : that an increased production of home-grown food is of paramount importance to our own country.

There are two main reasons why this is so urgent. We have to remember that in the industrial changes which have taken place since the war many of our industries have either disappeared or have been so reduced in amount that there has been a serious displacement of labour. So far as one can see, there is no prospect of these industries recovering their former size in this country, and, while new industries may be introduced, there is a grave fear that the displacement of many workers from their previous occupations is permanent. No better way of using this displaced labour can be imagined than to employ it on the land to increase our home agricultural production. It is unnecessary to point out or minimise the obstacles to so profound a change—the disinclination of an urban population to move to the country, the problems of housing and wages, and the necessity of obtaining a remunerative price for the food produced are only some of the more obvious difficulties involved.

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[1] Planning and World Markets, *Scot. Jour. Agric.*, vol. xvi., No. 1, pp. 3-15.

The second reason is equally important, and that is to supply the consumer with as large a proportion as possible of fresh food which has not been subjected to chilling or freezing or to any of the chemical manipulations or treatment which are much too common nowadays. The deleterious effects of some of these processes on the general quality of food is now well appreciated, and it is certain that, no matter how carefully these methods are carried out and controlled, the resulting product is not as good as the fresh material. The aim of the home producer should be, therefore, to produce the type of food in largest quantity where this quality of freshness is of the highest importance—*e.g.* meat, milk, butter, eggs, poultry and market-garden produce and fruit. In this way he can best meet the menace of overseas competition. At the same time much work will require to be done to educate the consumer to appreciate the superior value of fresh home-grown food as against that which has been chilled or preserved. It is quite certain that the consumer will not purchase home-grown produce for sentimental reasons: he will have to be convinced that the quality is better and that he is getting equally good value for his money. It will be necessary in this connection for the home producer to study the public taste a little more carefully perhaps than he has done in the past.

The modern farmer must now choose between two courses. He may either adhere to traditional systems under which his products have to meet those of overseas competitors who possess dominant advantages in the production of most of their crops, or, on the other hand, he may alter his system to meet the new conditions and produce those commodities which will command an unassailable position in the home market.

This alteration in the system of farming will mean many important changes; more concentrated foods must be grown at home, and less concentrated foods imported. In this connection the highly nutritive quality of young grass and the methods for its utilisation should receive more attention; the growing of hay on a quality basis and the adequate use of silage should also be mentioned.

Another problem to which sufficient attention is not being paid at present is the use of the poorer quality of land, such, for example, as we find in Scotland at elevations of 600 feet and over. Much of this, under proper methods of management, could produce a larger number of store cattle, milk and milk products, and poultry than it does at present. In more favourable times the possibility even of further land reclamation should not be overlooked. It may seem futile at a time when there is such difficulty in getting any adequate return from our best land to suggest that further land should be reclaimed; the present conditions, however, will not, we hope, be permanent, and we have to consider what may be possible in more normal times. The spectacle of large areas of land suitable for reclamation and close to our great industrial centres reflects little credit on the agricultural policy of the past generation or two. In many of these areas there are abundant supplies of labour near at hand, and the difficulties of housing and transport would be reduced to a minimum. It is not suggested that at the present such reclamation would be economic, but as a means of using unemployed labour it would at least have the merit of leaving something tangible as the result. In an article contributed to *The Times* last November, Sir Daniel Hall gives an interesting account of the enormous reclamation and land drainage work which has been carried out in Italy during the past ten years, and points out that the agriculturally minded man must regard it as the biggest bit of constructive work since the war ended. In conclusion he says: "A great work. But what of the cost? As yet, it is impossible to judge of the finance, for who shall say what land is worth or is going to be worth? But the Italian State is said to have expended £31,000,000 gold in the last ten years on 'Bonifica,' against which it is claimed that over a million acres have been or are being reclaimed. The severely economic English view would be that, since land is going out of cultivation, it is waste of money to make more. But in Italy men do still live by the land; the money has been spent in Italy and almost wholly on labour, and there is something real and lasting to show for the expenditure. It is a return to the high Roman way, to the courage that drove the first roads and built the bridges through Barbarian Europe."

The importance of agriculture, not merely as a means of producing additional home-grown food, but as an industry of fundamental social value, is now being realized by all sections of the community.

With the good offices of statesmen, scientists, economists and others interested, and with the goodwill of the people at large, it is not too much to hope that the British farmer will choose wisely, and that the character and energy which have distinguished him for generations will enable him to secure once more for our British agriculture that prosperity which is vital to the welfare of our nation.

MECHANICAL DRAINAGE OF SCOTTISH SOILS

M. M. MONIE, M.A., B.Sc.

IN a previous paper in this journal, "The Application of Mole Draining to Scottish Soils" (January 1930), I described a mole plough used in exacting field trials at Barochan, Renfrewshire, and predicted that this method of land drainage had a useful future. Since then the tractor-operated draining outfit has been developed along very useful and comprehensive lines, and it is proposed to describe this advance in the present article.

The first result of the Barochan trials was to stimulate interest in mole draining, and during the last few years many hundreds of miles of such drains have been drawn. The range of mole drains existing in this country extends from those of recent date up to some of twelve years old, and of the drains examined 95 per cent. were effective and running freely. Erosion of the top and bottom of the tunnels was noticeable, and in some of the sandy boulder clays the wear was to the extent of 1 to 2¼ inches after five years' run. It may seem strange to talk of mole drains in *sandy* boulder clays, for most people associate the mole plough with clays, especially stoneless clays. But many boulder clays of sandstone parentage, where " fine sand " is abundant, have a texture close enough and sufficiently tough to form durable mole tunnels. When these have a " cover " of 18 inches or more of soil material, they are protected quite adequately by this pneumatic buffer from any ill effects of surface traffic and the shocks due to carting or cultivation of the farm. Nevertheless, there is a point reached when the subsoil crumbles too readily for mole drains to remain long in action, and the writer has given some attention to the possibility of designing an instrument which might aid the drainer in estimating the soil texture quickly and accurately, so that he might gauge when mole draining might be applied and when the tunnel needed the support of tiles.

The usual method of estimating soil texture is by the time-honoured mechanical analysis in which the soil sample is reduced to its component particles and the percentages of each weighed or otherwise measured. But this is *analysis* and we desire synthesis : we wish to measure a resultant depending on the behaviour of the total mass of soil particles and disposed in granular or platy aggregates according to the structure of the type of soil under examination. This is best accomplished by dealing with the soil in situ, and after many experiments I have produced the texture-measuring auger shown in Fig. 1.

The cutting blade is a single whorl of steel of such pitch and dimensions as to slip easily into any soil without much displacement of the soil grains. This auger is turned from a solid bar of steel and is uniform in every respect from one end to the other. The core removed by it is fully 2 inches in diameter by 5 inches long. At the point where the auger whorl finds its lower termination, a strong vee edge is fixed (Fig. 1—C) to notch the outer edge of the whorl of soil sandwiched between the blades, so that when the tool is withdrawn it raises with it a cylinder of soil—otherwise the auger would tear out an irregular cone of earth.

An auger of the dimensions indicated above requires a pull of over 400 lbs. to draw it out of clay and is moved by a lever and dynamometer acting on the cross-bar CB, which slides on the tubular stem of the instrument and may be firmly secured in any desired position by a small bolt. The stem terminates in a tubular handle H giving a total length of some 4 feet, which is suitable for all ordinary work, but could easily be extended. It is proposed to design a small pattern of this auger for ordinary popular use.

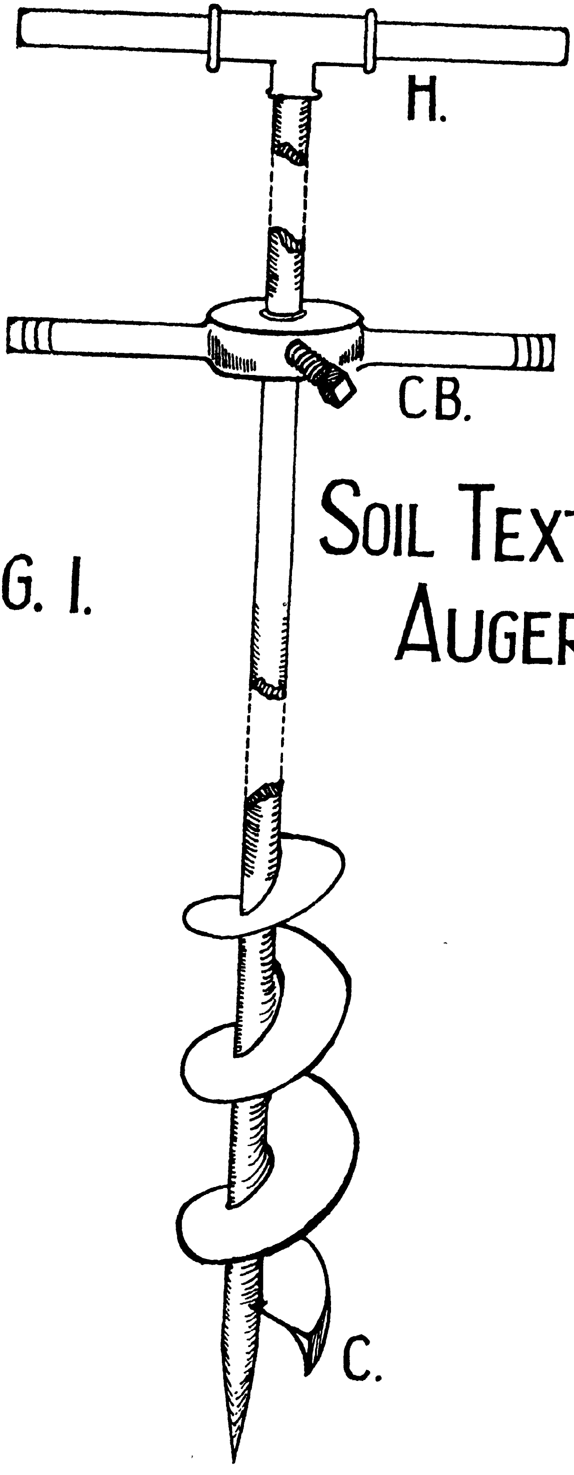


FIG. I.

SOIL TEXTURE AUGER

In practice, the instrument is screwed into soil or subsoil until the screw is just submerged; then the pull required to cause the auger to shear the soil is measured in pounds. Soils vary in their reactions to the auger. In stony or brashy materials the readings vary more than in alluvial deposits. Heavy loams and clays bake hard in the surface layer during drought, giving excessively high figures; but this applies only to occasional years and then only to a few weeks; and such soils, if requiring to be drained, are usually damp in the lower layers during drought so that normal readings may be readily secured.

The use of this instrument, under varying conditions, is at present being worked out, and for our present purpose it is sufficient to say that, for mole draining, the subsoil should show a texture pull of 200 and upwards; at 350 upwards the tackle needs to be specially strong, and at 400 the deeper open drains have to be cut in two instalments. It is hoped finally to correlate drainage practice with the texture numbers and soil structure, and to do away with the need for so many mechanical analyses in soil work. In fact the farmer and factor and land agent may find the texture auger useful: we may yet see estate advertisements reading, "The soil on the higher ground has a texture of 130 to 155, on the carse below the house of 380 to 410 and, in the gardens, 160."

In some of the mole-draining operations in heavy soils the ordinary vertical cut of the main coulter was modified to leave a vee at the surface which (9 inches deep by 2½ inches across the top) was filled with ashes or small stones. This proved most effective and led to a rapid discharge of ground water, so rapid, in fact, that many observers, who examined the outlets after a wet period, declared that the tile drains were working well, but *the mole drains were a failure* as they were dry. The fact was, of course, that the mole drains had finished their work before the observers appeared on the scene! In soils which proved too friable for mole draining experiments showed two ways of filling the mole tunnel with two linings—(1) tiles, (2) wooden tubes of triangular cross-section.

In mole-tile-draining, tiles, strung like beads on a thin wire rope, are pulled into the mole tunnel behind the tool which shapes it. To the first string is added a second until 100 yards of tiles are thus laid. The resulting channel is very well laid and the inner surface on inspection is as true as the barrel of a gun. It has been found, however, that this operation is best carried out in stone-free soils, as even small stones tend to lodge between the moving tile-string and tunnel and break tiles.

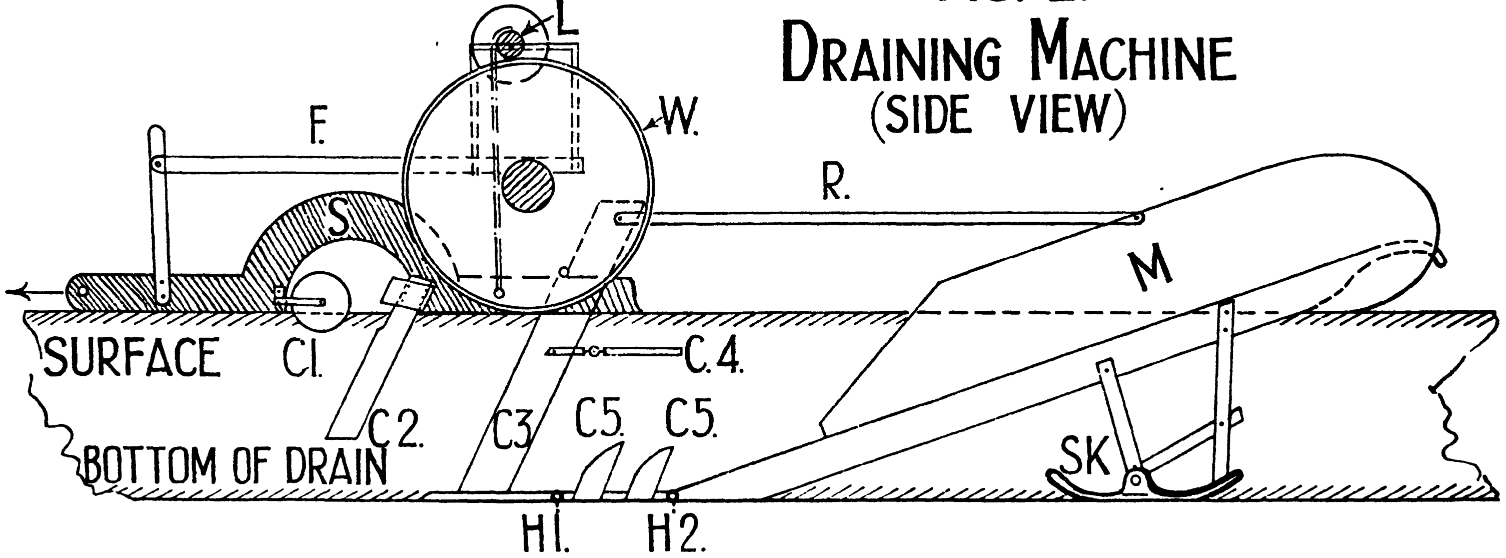
More useful results have been obtained with a drain-lining of beech-wood, where such can be secured cheaply from sawmills. The wood is cut to size, 3½ inches wide by ½ inch thick, and of varying lengths. These wooden strips are formed into water conductors of triangular cross-section by means of wire couplings of "staple" design, and may be readily drawn into mole drains in series strung on a wire rope. Given a contract of reasonable size, say, running to some scores of acres, this method is reckoned to reduce the cost of land drainage from over £20 per acre to about £11. The wood may be expected to last for a very long time: the writer has inspected beech soles, dug out of mineral soil under a tile drain in Ayrshire, which were quite hard enough for further service at the end of a century in the ground. In medium or deep peat this system of pipe drainage has much to commend it, and the cost per acre under these soil conditions would be approximately £8—dry acres for a few shillings per annum. The wire couplings would suffer corrosion from peaty acids and might be replaced by wood or other suitable material.

Various machines have been designed for the excavation of ditches in ordinary subsoils, including tough, stony boulder clays. Many of these trench cutters have been successful only in selected materials and have failed utterly among stony subsoils. With the successful application of the mole plough to such layers, the way has been paved for the evolution of a machine embodying the central features of the mole drainer *plus* some coulters for severing the contents of the drain from sides and bottom *plus* a plough-like excavating unit placed astern to heave out the trench contents and shape the finished drain. A side view of this machine in cut is shown in Fig. 2. This is not drawn to exact scale, but is merely presented to show the general " lay-out " and the principles on which the machine works. The motive power is transmitted by a suitable wire rope actuated by a powerful winch fixed to the stern of a Fordson tractor and may amount to a pull of 20,000 pounds. As a rule, only half of this energy is required, but an ample margin is desirable, for serious obstacles like old stone drains or large boulders may be encountered. George Stephenson was asked what would happen if a cow got in the way of his new locomotive. He replied that " It would be a bad thing for the coo " ; and similarly this draining machine, when engaged in excavation, is capable, if plenty of power be available, of heaving a 2-cwt. boulder clean out of the ground and crashing through a stone drain without a tremor. The winch and machine present that dreadnought construction known as "Clyde-built," and are designed not only to work well but to wear well.

A high degree of efficiency is secured by streamlining all parts so as to reduce resistance to the minimum, and by providing hinges at suitable points to allow a reasonable measure of flexibility and give the cutting parts a chance to adapt themselves to suddenly varying resistances in the subsoil.

The pull of the engine is applied to the fore end of the steel sledge S (Fig. 2), which has a semicircular spring back and is built of steel angle-iron of heavy cross-section. S is provided with suitable fittings for the attachment of a group of coulters, *e.g.* C_2 and C_3, which slant forwards so as to pull the sledge into close

FIG. 2.
DRAINING MACHINE
(SIDE VIEW)



contact with the ground when the machine is in action: this pull is carefully adjusted so that the sledge may not become a brake.

The following coulters are used: (1) C_1, a sharp disc coulter cutting down to a maximum of 6 inches and set according to requirements; (2) a pair of knife-shaped side coulters, C_2, which are slanted to cut the sloping sides of the drain and adjustable as regards slope and depth; (3) C_3, a large central coulter which bisects (vertically and longitudinally) the total contents of the drain and carries a flattened mole cutter rigidly secured to its lower extremity, and so shaped as to diminish resistance and firm the flat sole of the trench; (4) the horizontal floating plate coulter, C_4, which may be used when it is desirable to separate the turf layer (as in peat) from the other materials excavated; (5) two small basal coulters, C_5, set laterally and raked on the sole of the excavator, which is hinged at H_1 and H_2, to give a worm-like movement among stony materials, thus saving those deep cutters from undue strain.

Astern of the cutting parts lies the excavating unit M, designed to throw out to the surface the material severed by the coulters and also to shape and finish the interior surface of the drain. This rear structure is plough-like with a pair of large and symmetrical mould-boards, supported below by the skid-plate SK which glides along the bottom of the finished trench. Stilts are provided at the rear for the use of the operator, but, in most classes of land, the machine is capable of running untended. The excavated subsoil is evacuated in two or four rows parallel to the drain and may be delivered to a distance of 1 to 3 feet from the margin —a position which does not interfere with the passage of the two widely set wheels W, which are far enough apart to clear all debris. The structure M is hinged at H_2, where it is connected to the cutting system at the sole-plate, and on a higher level is braced and controlled by the heavy rod R which is pivoted to the top end of C_3 and has an adjustable screw-control in a pivoted block rearwards, where it unites with the upper frame of M.

The cutting parts are raised or lowered by a gear system and wire rope L mounted on a frame carried above the -()- axle of the two wheels W. At the commencement of a cut the machine moves forwards and downwards into action: there is no need to dig a pit for it. At the end of a cut the coulters are raised to the surface by the lifting gear L, and the machine moves off behind the tractor at ordinary walking pace to recommence operations.

The cutting capacity of this draining machine is 27 inches deep by 2 feet wide at top to 3 to 6 inches at bottom—with adjustments for depth and batter to cut drains of any cross-section desired within these limits. Working on the same principle, it would be possible to cut drains to larger sizes given suitable power. The speed of the machine ranges from 8 yards to 16 yards per minute: at the recent tests at Meadowhead Farm, Ayrshire, local drainers remarked that it would take them a forenoon to cut by hand an

FIG. 4.—Drain cut in heavy loam at the rate of 15 yards per minute—untouched by hand.

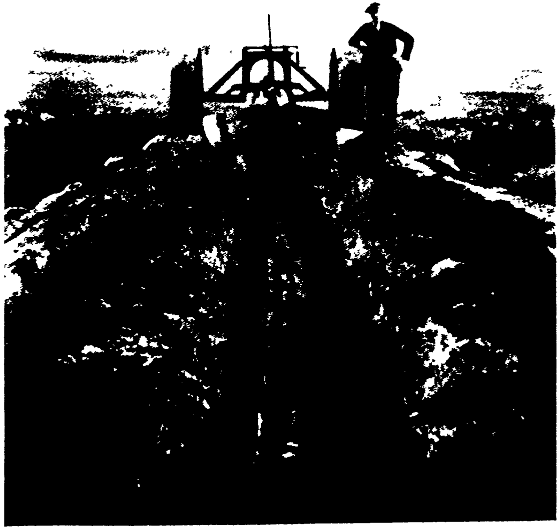


FIG. 5.—Peat Drain cut with machine at 2 miles per hour, using a Caterpillar Tractor. Cost is about £1 per mile.

open drain excavated by the machine in 3 minutes, and the work would not be so well smoothed off and finished (see Fig. 4).

Fig. 3 shows a cross-section of a drain with the traces of the coulter cuts.

By disconnecting the rear portion M, rod R and coulters C_5, C_4 and C_2, the machine becomes a mole plough, with the usual torpedo coulter fixed to the lower end of C_3 : this change over may be effected in 10 minutes and is very necessary in most draining contracts, where it is expedient to combine mole and tile draining.

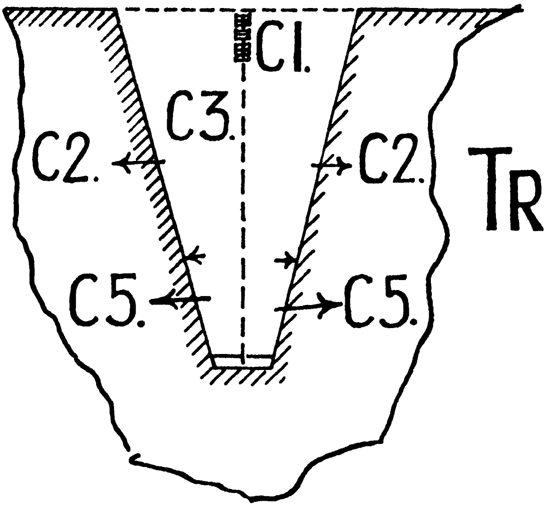


FIG. 3.
TRENCH IN
XS

In the deep peat (Fig. 5) which covers such extensive areas of Lowland Scotland, and is often present to a depth of 20 feet over tens of thousands of acres, this draining apparatus has proved very effective. Another field of usefulness lies among the Scottish upland grazings. The most useful motive power under such conditions is the larger size of caterpillar tractor which provides a high drawbar pull under the trying circumstances found in the centre of a wet bog, swaying up and down as one walks across it, or in the rough grazings frequented by the Blackface sheep. In this peat work the coulters C_5 are exchanged for two backward-curving sabre-shaped knives and the cross-coulter C_4 is in operation. The peat is cut from the sides and from below, and being, as a rule, water-logged, glides freely out and up to the surface. In a trial on deep peat on the Macaulay Experimental Farm at Arnish, Isle of Lewis, the machine cut open drains (20 inches deep, 24 inches wide at the surface and 12 inches wide at the base) at a speed of 2 miles per hour. The cost was reckoned at £1 per mile.

Hard pan or moor pan interferes with free drainage of many soil types and occurs in boulder clays, in alluvial soils, in blown sands and in many other deposits. This hard layer of naturally-cemented material is often present at depths encountered by the draining machine, and many varieties may be broken by the mole plough. Where very thick, the pan may be shattered here and there by dynamite, and considerable bodies of soil-water have been set free to flow to the main outlet by the skilful use of explosives in the right place.

In times of drought in Scotland, when the upper soil layers of clays and clay loams are very hard and resistant, the passage of the mole-draining machine may be somewhat impeded, but it is very seldom indeed that this happens and the power available is usually ample to deal with a dry upper crust.

So far we have discussed drainage in relation to agriculture, but there is important work to be done in other fields, for example, in sports grounds and aerodromes. These call for intensive drainage. The agriculturist is content if his land dries in 24 hours, but the aviator prefers to see excess water moving off in 24 minutes! A system of intensive drainage by machine has been introduced by the writer and has given excellent results on aerodromes. Tiles (3-inch) were laid 22 inches deep and 3 yards apart with sods on the top of the tiles. Across the tops of the tile drains, and running at a high angle to same, were cut a set of 3-inch mole drains, 17 inches deep and with gash tops to the coulter cuts (2 inches by 9 inches) which were filled with small rubble. This system absorbs the heaviest rainfall quickly, and the mole drains, pierced by a spike where they cross the tiles, only carry the drain-water for a few feet and so are saved from undue erosion.

From the foregoing description of the advance of mechanical draining plant of a portable kind and capable of dealing with a wide range of soils, it is clear that a renaissance in land drainage is at hand. Costs may be reduced from £20 per acre to £10 or less, and in mole draining to £2 or £3. The work may be greatly speeded up, for a machine is equivalent to 56 men. The quality of mechanical work is above that performed by the manual drainer. It seems to me that, with the machine as leader, great numbers of men might well be employed once more to raise the derelict lands of Scotland to a higher level of agricultural production.

Census of Agricultural Production

THE fourth Census of Agricultural Production in Scotland was taken in the year 1930–31, and the Report on it will shortly be issued by H.M. Stationery Office.

The Census deals with the crops harvested in the autumn of 1930, with live stock and live-stock products produced during the period 1st June 1930 to 31st May 1931, and with vegetables, fruit, etc., produced during the calendar year 1930. In the previous Census, taken in 1924–25, the arrangements were somewhat different, the crops dealt with being those of 1925, live stock and live-stock products those of June 1924 to May 1925, and vegetables, fruit, etc., those of the calendar year 1925. The scheme now adopted brings the various items nearer to a single period of twelve months, but this cannot be done precisely.

Considerable changes are revealed by a comparison with the figures obtained in the previous Census. The whole area under crops and grass was less in 1930 than in 1925 by 64,500 acres ; arable land was less by 157,500 acres, while permanent grass had increased by 93,000. The fall in the area of arable land was mainly accounted for by oats, with a decrease of 64,000 acres ; barley, with 46,000 ; turnips and swedes, with 23,000 ; and potatoes, with 19,000. The first three figures are in accordance with a regular movement, but the acreage of potatoes in 1930 was exceptionally small, by reason, no doubt, of the poor prices realised for the excessive crop of 1929.

The total number of horses on farms fell between 1925 and 1930 by 29,000, while those used for agricultural purposes were reduced in number by 16,000 ; in 1931 a further fall of 3,650 took place in the total number, horses used for agricultural purposes being fewer by 3,010. Cattle were more numerous in 1930 than in 1925 by 31,000, but in 1931 they fell back to a total exceeding that of 1925 by only 4,000. This small increase was wholly accounted for by dairy and breeding cattle, the number of " other cattle " being almost the same in the two years. There was, however, a striking difference in the age distribution.

		1925	1931	Difference
Other Cattle	Two years and above	236,072	194,019	−42,053
	One year and under two	276,900	293,315	+16,415
	Under one year	224,099	249,618	+25,519
	Total	737,071	736,952	− 119

This table shows the change that has taken place in the age at which cattle are normally slaughtered. It should be pointed out that since 1931 a considerable increase in cattle stocks has been recorded, the total in 1933, according to the Preliminary Statement, being 1,278,900, which is the highest on record

Sheep in 1930 showed an increase of 530,000 over the number returned in 1925, and a further increase of 181,000 took place in 1931, when the record total of 7,831,000 was returned. For a number approaching this we have to go back forty years. A still larger number was recorded in 1932. The steady increase in the number of sheep since 1920, when stocks were at their lowest, is one of the marked features of post-war agriculture in Scotland.

Pigs vary greatly in number from year to year. In 1925 and 1930 the numbers were somewhat below average, while large totals were recorded in 1927 and 1928 ; in 1931 there was a considerable increase over the total for 1930.

Poultry, on the other hand, showed an increase between 1925 and 1930 of 16 per cent., and in 1931 a further rise of 11½ per cent. was recorded in a single year.

In estimating the value of the agricultural output, account is taken only of what is sold for consumption outside the farming industry and that consumed by farmers' families and staffs. Crops consumed by live stock on the farm are excluded.

The total gross value of the output from Scottish farms in 1930-31 is estimated at £38,000,000. Of this amount about £30,800,000 was obtained by the sale of live-stock products, viz., meat, milk, butter, cheese, poultry, eggs and wool. Thus over 80 per cent. of the returns from agricultural production arises from live-stock farming. Farm crops, *i.e.*, grain, potatoes, sugar beet, hay and straw were valued at £6,350,000, leaving about £750,000 for vegetables, fruit and glasshouse produce. In 1925 the total value was £48,100,000, live-stock products accounting for £38,700,000, farm crops for £8,600,000, and vegetables etc., for £800,000. Live-stock products have thus increased their proportion in 1931 at the expense of farm crops.

Beef production was 148,000 tons (11,000 tons less than in 1925), valued at £12,000,000. The production of beef in Scotland is credited with that derived from about a quarter of a million cattle imported from Ireland for fattening and subsequent sale in Scotland. The production shows a fall of about 7 per cent. as compared with 1925, but the value has fallen by fully 25 per cent. Here, as in most of the items that follow, the fall in value reflects the reduced return accruing to the farmer for his produce, while the assessment of actual production is illustrated by the weights or numbers quoted.

The amount of mutton and lamb produced—63,000 tons—was almost 15 per cent. greater than in 1925, but its value was, owing to the heavy fall in prices, only £6,700,000, or fully 18 per cent. less than in 1925. Pigs produced about 14,500 tons of pork, bacon, etc., valued at £1,345,000. In this case a decrease in production of 2,500 tons is accompanied by a drop in value of roughly £100,000. Veal production in Scotland is relatively small, being in 1930–31 only 1,750 tons, valued at £215,000. The value of these four commodities accounts for over 50 per cent. of the total value of agricultural produce.

Next in order of importance come milk and dairy produce. Scotland's supply of liquid milk from home sources in 1930–31 was 127 million gallons, valued at £6,350,000. The production as compared with 1925 has fallen by 7 per cent., while the value is down by 15 per cent.; this shows that the price of milk was better maintained than that of meat. Butter and cheese, however, though little changed in amount from the earlier Census, have fallen in value by about 35 and 25 per cent. respectively. The amount of butter produced was 52,000 cwt., and its value £335,000, while 143 thousand cwt. of cheese brought in £590,000. The production of cream shows an increase of almost 90 per cent., both in amount and in value, these being 381 thousand gallons and £190,000 respectively.

The number of poultry sold, according to an estimate based on the actual returns received from farmers, was 2,000,000 hens and about 180,000 ducks, geese, and turkeys, but the figures are presented with some reserve as they are thought to be too small. In 1925 with a smaller poultry population the figures were 2,100 000 and 140,000. The value of poultry sold was £310,000.

The figures of egg production, though nearer the anticipated figures, are also given with reserve. It is estimated that 327 million fowls' eggs and almost 12 million duck eggs were sold, giving values of £2,040,000 and £80,000 respectively. These figures include only eggs produced on holdings exceeding one acre in extent. It is estimated that poultry kept elsewhere would produce about 50 million additional. The total egg production, from fowls and ducks, rose from 300 million in 1925 to 390 million, an increase of 30 per cent. The average number of eggs laid per hen was 118, as compared with 100 in 1925. The average may still be regarded as somewhat low, considering the progress of the poultry-keeping industry in Scotland in the period.

The total value of poultry and eggs sold, £2,430,000, is slightly above the total value of wheat, barley and oats sold.

The production of honey is estimated to have been 240,000 lb., valued at £24,000.

The wool clip of Scotland naturally showed an increase in keeping with that in the flocks and was estimated at 27,300,000 lb., including skin wool the value of which, however, is included under mutton. The wool clip was valued at £485,000, or less than half the value recorded in 1925. Although the Blackface and Cheviot breeds of sheep supplied fully 80 per cent. of the clip, it is noteworthy that returns were received in respect of nine other breeds.

Generally the weather of 1930 was less favourable for farming than that of 1925. Despite these conditions, the yields obtained per acre were up to the average of the preceding ten years, and, with the exception of wheat, were very similar to those obtained in 1925. Wheat, a crop confined practically to the best farm land in Scotland, amounted to 57,000 tons, of which 43,000 tons were sold off the farms. The latter amount is less than in 1925, but the value realised was only £230,000 as against £510,000 in the earlier year. Barley, which has of recent years become much reduced in area, gave 95,000 tons; the amount sold was 71,000 tons, valued at £370,000, as compared with 112,000 tons, valued at £950,000, in 1925. Of the gross production of oats, viz., 647,000 tons, it is estimated that 292,000 tons, valued at £1,800,000, were sold off the farms. Although the estimated quantity sold was slightly in excess of that sold in 1925, the value was less by about £76,000.

The potato crop, 860,000 tons, was less than that of 1925 by 135,000 tons, and the quantity sold off, about 710 000 tons, was also less than in 1925. Its value however—£3,231,000—is one of the few instances where a slightly greater return was obtained for the produce than in 1925. Sugar beet in Scotland, despite the subsidy scheme, has not developed largely as a farm crop, and in 1930 only about 11,000 tons were produced, valued at £28,000.

The hay and straw crops are mainly for consumption on the farm, but of the hay crop, which amounted in all to 920,000 tons, 117,000 tons were sold off the farms at a value of £415,000. The proportion of straw sold off is very much smaller, as out of a total produce of 1,290,000 tons, only 100,000 tons were sold, the value being £240,000.

Orchard fruit is a diminishing industry in Scotland, though there are signs of a revival of interest in plums, pears and cherries. The total production of all kinds in 1931 was only 26,000 cwt., valued at £15,000. The area under small fruit, on the other hand, while showing changes in distribution as to kinds, tends to increase. Though, like wheat, a localised crop, mainly in Angus, Perthshire and Lanarkshire, it finds a market not only in Scotland but also in England. Strawberries yielded 42,500 cwt., valued at £98,000, while raspberries gave 155,000 cwt., valued at £135,000. Currants, gooseberries, etc., yielded 29,000 cwt., with a return of £28,000. These figures are, however, somewhat out of date as giving a picture of the small-fruit industry to-day ; since 1930 the area under strawberries has decreased by 13 per cent., and that under currants and gooseberries by 12 per cent., while that under raspberries has increased by 3 per cent.

Of common vegetables—turnips, carrots, cabbage and rhubarb —Scotland produces an excellent supply. The home produce of these for human consumption in 1930 is estimated at 62,000 tons, valued at £144,000. There were also produced about 8,500 tons of brussels sprouts, cauliflower, leeks, lettuce, peas, etc., giving a total value of £43,000.

The trade in flowers (including plants, cut flowers, bulbs, etc.) is on the increase in Scotland, having risen in value from £20.000 in 1925 to £22,000 in 1930. This does not include flowers grown under glass, which in 1930 were valued at £26,000. Here also there is evidence of an increase as compared with 1925.

Glasshouse produce in Scotland covers a varied list of commodities, the most important of which is tomatoes. The crop in Scotland in 1930 was estimated at 60,000 cwt., valued at £160,000, as compared with 40,000 cwt., valued at £100,000, in 1925. To-day the production must greatly exceed these figures, as it is known that since the Census was taken, the industry has developed considerably. The remainder of the glasshouse produce was valued at £51,000.

Particulars have been obtained in each successive Census of the agricultural machinery in use on farms. Since 1908 the total number of fixed and portable machines of all kinds has been almost quadrupled. Since 1925 the increase is 20 per cent. The total number of fixed or portable engines in 1930-31 was 18,327, of which nearly 15,000 were driven by oil or petrol and 2,212 by water. Of motor tractors there were 2,452, of which 1,782 were used for field work and 670 for stationary work. These machines have increased in number since 1925 by 45 per cent. About half of them are used in the south-east of Scotland, and they are naturally found on the larger farms.

EXPERIMENTS IN THE IMPROVEMENT OF HILL PASTURE

R. G. Heddle, M.A., B.Sc.
Edinburgh and East of Scotland College of Agriculture
AND
W. G. Ogg, M.A., Ph.D.
Macaulay Institute for Soil Research, Aberdeen

Hill grazings occupy a large proportion of the land surface of Scotland and are of great economic importance in Scottish agriculture. They show a wide range of variation in character and in productivity, and this variation depends on various factors, such as soil conditions and past treatment, geographical position, altitude, aspect, steepness of slope, rainfall and geology.

In any one locality only a limited number of the various types of hill grazing will be found. The work described in the present paper has been carried out on the hill-land attached to the experimental farm of the Edinburgh and East of Scotland College of Agriculture at Boghall, Midlothian, an area typical of much of the hill grazings of the Pentland Hills. The work, however, is of more than local interest, for similar herbage types occur in many other parts of the country, and in the aggregate they cover a large area. The investigation was commenced in 1923 by the late Dr W. G. Smith, with whom the preliminary part of the work was carried out.

Situation and Topography.—The farm is situated on the south side of the Pentland Hills, five miles south of Edinburgh. The hill grazing, which extends to about 340 acres, consists of the eastern and southern slopes of Caerketton Hill, the eastern slope of Allermuir Hill, and a flattish area of Boghall Glen at the bottom of these slopes. A small stream, Boghall Burn, which flows along the middle of the Glen, forms the southern boundary. The bottom of the Glen is moundy at the entrance and flattens out towards the upper end. From the flattish and moundy areas there is at first a gradual rise to a height of 1000 to 1250 feet, where the slope becomes steep; on the hill-tops there are flat areas. Part of the lower ground of the Glen has been at one time under cultivation, and traces of buildings, indications of ridging and of one or two field boundaries still remain, but cultivation has long since been abandoned. Most of the area, including all the higher ground, has never been cultivated, but has been used as grazing land principally for sheep. There are no records known to the writers of liming or other manurial treatment, but a certain amount of draining by shallow open drains has been done, and the heather and grasses have been burned from time to time. The average rainfall at the farm steading below (at an altitude of 645 feet) is 36 inches per annum.

Herbage Types and Soils.—It is not proposed in the present paper to give a detailed account of either the soils or the herbage types which occur in the Glen. The geology of the area has been described by Hart,[1] who has pointed out that the rocks over the whole area are volcanic in origin and may be divided into two main groups—a basic, consisting of basic andesites and basalts, and an acid, consisting of acid andesites, rhyolitic lavas, trachyte and tuff.

The basic group occupies about two-thirds of the total area and is separated into two sections by the belt of acid rocks. During the glacial period the whole region was covered by ice which has left deposits of glacial drift. On the higher ground the drift, except in spots, is thin or absent, but on the lower ground the rocks are covered by boulder clay and by sands and gravels. There are also small areas of alluvium and peat. In spite of a good deal of mixing of the basic and acid materials the area over the acid belt of rocks can be picked out from the opposite side of the Glen by the difference in vegetation. This variety in the parent materials is reflected in the diversity of soil types which is to be found in the Glen. Marked differences in depth, texture, moisture conditions, acidity and other characteristics are met with, and these differences are associated with equally striking variations in the vegetation from place to place. The different herbage types vary among themselves, not only in their inherent value as grazing for sheep, but also in their response to different methods of treatment designed for their improvement. Some of them respond well and rapidly, while others are highly intractable. A brief summary will therefore be given of the outstanding features of the various types which have been under experiment, with reference to their botanical characteristics and the associated soil conditions, as well as their value from the point of view of providing food for stock. It will be understood that while the types described are well defined and recognisable, the line of division between different types is not always clearly marked and various intermediate types may occur.

Moist Flush Pasture.—This may be described as a "bent-fescue" type, being dominated by bent-grass and fine-leaved fescues. Both sheep's fescue and the more luxuriant red fescue occur, but the latter is decidedly more prominent than in the areas of "short dry grass" described below. A variety of broad-leaved grasses is mixed with the dominant species, Yorkshire fog being generally a prominent constituent, while sweet vernal grass, crested dogstail and smooth-stalked meadow grass are of frequent occurrence. White clover is present throughout, and locally, where the ground is subject to rather heavy flushing with water rich in mineral bases, may become very prominent. In such situations, Yorkshire fog, crested dogstail and rough-stalked meadow grass also tend to become prominent. A variety of miscellaneous plants occurs, including bedstraws (*Galium spp.*), field woodrush (*Luzula campestris*), and others, and locally the creeping thistle may be abundant.

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[1] R. Hart, "Studies in the Geology and Mineralogy of Soils," *Jour. of Agric. Science*, xix., 90 (1929).

This is to be regarded as the most valuable herbage type in the Glen from the point of view of sheep grazing. It is one of the most productive types, and is kept fairly constantly cropped by the sheep, so that the grasses are not allowed to flower to any marked extent and the herbage does not become rough.

This type of pasture occurs chiefly on those parts of the lower slopes of the hill where the surface material derived from the basic rocks has been carried down the slopes, and where there is a moderate amount of moisture present even in the summer months. The moisture may come from springs or from water trickling down the slopes on the surface of the underlying rocks or boulder clay. This water keeps the surface soil moist without making it very wet, and chemical analysis and conductivity measurements show that the water is fairly rich in bases. The soil is a well-drained reddish brown medium loam of good depth, and the subsoil varies from a loam to a clay loam. The soil has about the same content of organic matter as a normal cultivated loamy soil and there is no peaty layer on the surface. There is a moderate degree of acidity, but the acidity and " lime requirement " are not greater than are shown by many fertile arable soils. The " available " potash is about normal in some areas, and rather below normal in others ; the " available " phosphate is very low and much below the average for cultivated soils.

Similar pasture is also found on small areas of soils derived from boulder clay, where the drainage is good, and on alluvial materials laid down by one or two small streams in the Glen. These soils are derived from the same class of rock and are also moist throughout the year.

Wet Flush Pasture.—This type varies somewhat according to the degree of wetness of the soil. In the wettest parts rushes and sedges become dominant, but where the moisture is not so excessive the herbage is dominated by a mixture of grasses, mainly rather luxuriant broad-leaved species. Bent-grasses and Yorkshire fog are usually the most abundant species, along with fine-leaved fescues (especially red fescue), sweet vernal grass, white moor grass (*Nardus stricta*), crested dogstail, tussock grass (*Aira cæspitosa*) and others. White clover is present, but is usually suppressed by the dense growth of grasses which is not well grazed by sheep. Another prominent leguminous species is the greater birdsfoot trefoil (*Lotus uliginosus*). Numerous miscellaneous plants occur, those characteristic of wet situations, such as sedges, being conspicuous.

This is a fairly productive type of pasture, but its palatibility to sheep is not high and it is often allowed to become very rough.

The soils on which this type of pasture occurs are also formed on the lower slopes of the hills where the underlying rocks are basic in character. They are derived from a thin covering of hill downwash overlying stiff boulder clay or rock, and a characteristic feature is wetness at the surface. The water, however, is not stagnant, but percolates down the slope and is kept close to the surface by the boulder clay or rock. It is similar in composition to the water of the "moist flush" type.

The soil has a greyish tint and is rather shallow, and sometimes gravelly, but it contains a fair amount of clay. The content of organic matter is about the same as in the previous soil, although here and there it is slightly higher, but there is no peat formation. As in the previous case, neither the degree of acidity nor the "lime requirement" is high. The "available" potash and phosphate contents are also similar to those on the soils of the "moist flush" type, the potash being normal to slightly below normal and the phosphate very low.

Short Dry Grass.—The light soils derived mainly from glacial sands and gravels carry a herbage dominated by whins. If allowed to grow without interference the whins rapidly form a dense thicket which practically excludes all other vegetation. Much of this whin area, however, has been burned, and although the whins gradually recolonize the ground by the growth of new shoots from the stumps, the ground between the bushes becomes colonized by grassy vegetation of a not very luxuriant type. This is essentially a "bent-fescue" herbage, bent grass and sheep's fescue being by far the most abundant grasses. Other grasses are decidedly subordinate, although *Nardus* tends to invade the ground, forming coarse tufts and interfering with grazing. Associated with the bent and fescue is abundance of heath bedstraw (*Galium saxatile*), the three species together constituting the bulk of the herbage. White clover is generally absent or sparsely developed in isolated spots. As a result of the extremely dry condition of the soil, productivity is low, but the herbage is moderately well grazed, except where grazing is interfered with by the presence of whins, nardus or bracken. The last-named plant is fairly abundant in places and locally becomes rather dense, interfering considerably with grazing.

The soils which carry this herbage occur in the moundy areas of glacial sands and gravel towards the bottom of the Glen, and are sharply differentiated by their dryness from the two types described above. The dense mat of bent and fescues forming the vegetation acts like a thatch and tends to run rain water off the surface so that even after heavy rain the soil often remains quite dry, while the moisture from the higher slopes passes through the pervious gravelly underlying material at too great a depth to influence the surface soil.

The surface layers of soil consist of a gritty light loam, greyish in colour, powdery, full of grass roots and difficult to wet. Below this there lies a brown, pervious, gravelly, sandy loam. The content of organic matter is nearly double that of normal cultivated soils of similar texture, but there is no tendency to peat formation and the organic matter appears to consist of fine fragments of the remains of grasses.

The soils are very acid and have a "lime requirement" which usually ranges from 3 to 5 tons of calcium carbonate per acre. The content of " available " potash is moderately high when estimated on a given weight of soil, but the soil is light and bulky. Even when allowance is made for this, however, there is a considerable supply of potash. For the same reason, although the amount of " available" phosphate is higher than in corresponding weights of soil from the moist and wet flush areas, this soil is very deficient in " available " phosphate.

Short Grass with Blaeberry.—This type resembles in some degree the " short dry " type, but differs from it in being associated with considerable quantities of blaeberry (*Vaccinium Myrtillus*) and the relative scarcity or absence of whins. The grassy herbage is of the rather fine leaved, non-luxuriant type, consisting for the most part of sheep's fescue, bent grass and wavy hair grass (*Aira flexuosa*). *Nardus* is abundant in places, and the miscellaneous plants, such as tormentil, heath bedstraw, etc., are mainly those characteristic of somewhat heathy situations. White clover is absent; locally heather is abundant and on flatter surfaces may become dominant. Productivity is not high and grazing only moderate.

This type of vegetation occurs on the higher and steeper slopes of the hills and chiefly on residual soils from the basic rocks. On account of the steepness, the soils do not develop to any great depth and there is a tendency for the finer material to be removed.

In places where the grasses predominate in the vegetation, the surface layer of the soil consists of a dark brownish-grey fluffy loam of light texture, not unlike the surface layer of the soil on the type just described. Where blaeberry or heather predominates, the surface layer is blackish and peaty. The peaty layer is usually 2 to 5 inches in thickness and the peat is well decomposed and is mixed with mineral soil. The percentage of organic matter in these soils therefore varies considerably, ranging from about 20 per cent. in the grassy areas to 30 or 40 per cent. or even more in the blaeberry or heather areas.

At a depth of a few inches below the surface there is a dark brown silty layer, which passes into a reddish-brown, gravelly pervious loam. Below this is a dark reddish-brown gravelly mass full of rock fragments. Characteristic features of this soil are its high content of organic matter in the surface layer, its stoniness and low content of fine material, and the absence of irrigation by springs.

Both the surface soil and the subsoil show a very high acidity and "lime requirement," the latter ranging up to 10 tons of calcium carbonate per acre in the surface layer, and 6 or 7 tons in the subsurface. The content of " available " potash is high, particularly in the surface layer, but as in the soil just described, this is associated with its high content of organic matter. Even when allowance is made for the lightness in weight of the surface soil, however, the " available " potash content is fairly high. The amount of "available" phosphate, on the other hand, is extremely low, even lower than in the soils previously described.

Nardus with Blaeberry.—This type is distinguished by the dominance of the white moor grass (*Nardus stricta*). Along with this species, two other plants are present in abundance, viz., blaeberry and wavy hair grass. Other species are distinctly subordinate, although small plants of sheep's fescue and bent are not uncommon. That the flora is of a decidedly heathy type is shown not only by the dominants but by the associated species, heather, heath rush (*Juncus squarrosus*), tormentil, and other heath plants being of frequent occurrence. White clover is absent and leguminous plants of any kind are rare.

This type is of extremely low value from the point of view of sheep grazing. It is low in productivity and the herbage is very slightly grazed by sheep. *Nardus*, the dominant grass, is a coarse, fibrous plant of low palatability. The young shoots which develop in the spring are grazed to some extent by sheep, but after the plant begins to ear, which it does at Boghall about the end of May or early June, grazing practically stops.

This type of vegetation occurs chiefly on the moderately steep slopes some distance up the southern side of Caerketton Hill. It appears to be associated especially with the belt of acid rocks which occurs on this hill, but is not confined entirely to the area of acid rocks, and is typically developed where the acid rocks are overlaid with glacial drift containing a considerable amount of basic material.

The parent material of the soil, where typically developed, is boulder clay with a thin covering of downwash from the slopes above. The soil has a dark-brown to black peaty surface covering, varying in thickness from less than an inch to two or three inches. This type of surface is frequently found to be associated with *Nardus* and consists of 30 to 50 per cent. of organic matter. It passes into a grey-brown loam and then into a yellowish gritty and stony loam, with a substratum of reddish stony boulder clay. The moisture content of the surface is low during the summer months and although the subsoil is moderately well supplied with moisture, there is no evidence of pronounced water-logging. Irrigation with spring water does not occur.

The peaty surface layer shows an extremely high acidity and "lime requirement" corresponding closely with the surface layer of the "short grass with blaeberry" type. The "available" potash is high, even allowing for the low volume-weight of the soil, but the "available" phosphate is exceedingly low. The subsurface layer has a much lower content of organic matter (although it is still high), a slightly lower acidity and "lime requirement," a much lower content of "available" potash and a slightly lower content of "available" phosphate. The excessively high acidity and low phosphate content probably tend to restrict the vegetation to this poor type.

Nardus with Undergrass.—This type of vegetation is more or less intermediate in character between the extreme "*Nardus*-blaeberry" type and the "wet flush" type and it partakes in some degree of the features of both. *Nardus* is still the dominant or sub-dominant species, but is no longer associated with blaeberry as a co-dominant. The latter, while present, occupies a relatively subordinate position, its place being taken by a mixed grassy herbage in which bent, sheep's fescue, sweet vernal grass, wavy hair grass and Yorkshire fog are the most prominent species. White clover is rare and confined mainly to the neighbourhood of occasional springs. The greater birdsfoot trefoil occurs here and there, and in wetter spots rushes are common. Tormentil, heath bedstraw and field woodrush are frequent.

Productivity is rather low and the herbage is not well grazed and tends to become rough, but in both these respects it is superior to the "*Nardus*-blaeberry" vegetation.

This type occurs on the flattish areas and gentle slopes at the foot of Caerketton Hill. The parent material of the soil is generally boulder clay, but in places this is overlaid by alluvium and perhaps some hill-downwash. The boulder clay is a mixture of basic and acid materials, the acid predominating.

This soil is badly drained. It is frequently waterlogged to the surface and tends to be wet even in summer. The water is more or less stagnant, and chemical analyses and conductivity measurements show it to have a very much lower content of bases than the water of the "wet flush" areas.

The surface layer of the soil is a dark brownish-grey loam, mottled with rusty spots, and has a slightly higher content of organic matter than normal for mineral soils. The acidity and "lime requirement" are both very high, but not quite as high as those of the surface layers of the "*Nardus*-blaeberry" soil. The "available" potash content is about the normal amount for arable land, but the "available" phosphate is again extremely low.

The sub-surface layer is dingy-grey, mottled with reddish-brown spots and putty-like in texture. The organic content, acidity and "lime requirement" are all lower than in the surface layer and the "available" potash and phosphate very decidedly lower.

In its high moisture content this soil has affinities with that of the "wet flush" type, but appears to differ in the water having a lower content of bases and being more stagnant. The "wet flush" soil has a much lower acidity and "lime requirement" and a rather lower content of "available" potash.

Compared with the "*Nardus* with blaeberry" soil, this soil shows similarities in acidity and "lime requirement," but is very much wetter.

Experiments with Manures.—Experiments with manures have included trials with phosphatic and potash manures as well as with lime, and have been carried out on all the herbage types described above. The results as measured in terms of improved grazing by the sheep and changes in the herbage have been very different according to the manure applied and the herbage type treated.

Potash manures have not been effective in improving the pasture at Boghall. Generally there has been a slight increase in grazing immediately after the application of the manure, a feature due apparently to the salty nature of the potash improving the palatability of the herbage, but this is only a temporary effect and no permanent improvement has been recorded. This absence of response to potash is perhaps not surprising, in view of the fact that the soils in general contain a considerable amount of "available" potash and, as mentioned later, other conditions were by no means ideal for obtaining a response. It does, however, emphasize the need for trials of potash manures on grasslands of different types coupled with soil analyses.

In the case of lime, too, the results have been poor, very little response to lime having been shown by any of the herbage types treated. In the case of the "flush" types this result is not unexpected, as the soils associated with these are not highly acid and do not show a high "lime requirement." It might have been expected, however, that the herbage associated with the more acid soil types would have shown a response to liming, but this did not prove to be the case. Even heavy dressings of lime have not effected any appreciable improvement, and soil analyses show that they have had remarkably little effect on either the acidity or the "lime requirement" of the soil.

The response to phosphatic manures has been much better, but by no means similar on all types of herbage. In some cases a good response has been obtained, in others none whatever. The best and most rapid improvement has been obtained on the "moist flush" pasture. Here an improvement has generally been noted in the first summer following the application of phosphates. White clover tends to spread into the rougher and more matted parts of the pasture and grazing improves. The coarser "wet flush" pasture is slower to respond, and it is generally not until the winter after the application of manure that any definite increase in grazing becomes visible. After this, however, a distinct improvement has been noticed, the rough herbage being better grazed and white clover spreading. In the wettest places, where rushes dominate, little improvement has been noted. The sheep tend to avoid this coarse unpalatable herbage. The dry whin pasture has proved disappointing in its response to manuring. Here and there where sheep are in the habit of lying, and there is in consequence a fair amount of white clover and moderately close grazing, an improvement has been noted, although it is generally slow and requires two or three years, but on the whole this herbage has not proved responsive to manurial treatment.

On the remaining herbage types no appreciable improvement has been recorded as the result of manuring. On a few rather untypical parts of the "*Nardus* with undergrass" areas, where some flushing from springs occurs and a certain amount of white clover is present, some response has been obtained, but otherwise no effect whatever has been noted on this type. The failure of phosphate to produce any marked improvement on these types of vegetation is probably attributable to more than one cause. It is noteworthy that the unresponsive herbage types are all associated with a high degree of soil acidity and a high "lime requirement." How far excessive acidity is directly responsible for the failure is uncertain. In the case of the "short dry grass" it has been found possible to establish a much improved herbage without liming. An area of this ground has been used as a run for pigs, which have torn up and largely destroyed the thick surface mat. Seeds have been sown on the broken ground and a herbage consisting largely of perennial rye-grass and white clover has been established. It still remains to be seen how long this pasture can be maintained, but it does not appear that the high acidity on this area is an insuperable obstacle to improvement, provided the "mat" is destroyed and suitable plants introduced.

The presence of this dense mat and the absence or scarcity of superior herbage plants are, indeed, probably important factors in limiting the possibility of improvement of the unresponsive types of herbage by lime or manures. The effect of the mat is to encourage the growth of inferior surface-rooting species such as heath bedstraw and tormentil, and to discourage white clover and other better but deeper rooting plants. In addition to this, the mat must have a highly deleterious physical effect upon the soil below, preventing aeration and frequently holding up water, thus preventing manures or lime from exercising their full beneficial effect upon the vegetation.

The absence of superior herbage plants is a factor which applies with particular force to the "*Nardus*-blaeberry" herbage, from which the better hill pasture species are almost entirely absent, but it applies in some degree to all the types under consideration. White clover, in particular, is of importance in this connection. It is, above all others, the species which is most capable of responding to phosphates, its creeping, spreading habit enabling it rapidly to colonize new ground. It is, however, to all intents, absent from these unresponsive herbage types. The better hill grasses also, such as Yorkshire fog, red-fescue, crested dogstail and sweet vernal grass, occupy a decidedly subordinate position in the herbage. Experiments are now in progress to test the effect of combining manurial treatment with the mechanical destruction of the mat by cultivation, and the introduction of superior herbage plants by seeding.

Another factor partly responsible for the failure of manures to effect improvement is the impossibility of controlling the grazing on open hill pastures. In order that the full beneficial effect of lime or manurial dressings may be secured, it is necessary to supplement the treatment by hard grazing so as to reduce the rough herbage and give the finer bottom grasses and clovers a chance to develop unhampered by the smothering effect of coarse top growth. On a fenced field it is possible to regulate the stocking, but on an open hill the sheep cannot be confined to any restricted area, and in consequence they tend to neglect the rougher pasturage in favour of the shorter sweeter types of herbage. As a result manures applied to these rougher areas are hampered in their effect.

Irrigation Experiments.—Attention has already been drawn to the close relationship that exists between the distribution of the better types of grazing herbage and the presence of spring water at or near the surface. Those areas which are flushed by spring water are at once the most productive and, provided the drainage is efficient, the most palatable to stock. They are characterised by the presence in considerable quantity of the more valuable plants of hill grazings, such as Yorkshire fog and white clover, and show the most rapid and complete response to phosphatic manuring of any of the types.

This close association between the better pasture types and flushing suggests the possibility of extending the area of such flush pasture artificially by leading spring water on to areas not naturally watered. This practice, indeed, is an old one and many references to it are found in agricultural writings. More than a century ago Robertson [1] drew attention to the improvement that could be effected on hill-sides by artificial irrigation and recommended the practice as a means of augmenting winter keep for hill sheep. At that time the practice was evidently already an old one, for he states that although it had largely fallen into disuse, it was still carried on in the Sidlaws and elsewhere. About the same time, J. Smith [2] noted that where streams overflow their banks the herbage of the stream sides is improved, heath and coarse grass giving place to a closely-grazed fine herbage of early spring growth. He recommended the use of the water from hill streams to flush the slopes. Robie [3] suggested the utilisation of burns for irrigating mountain pastures, so as to replace heather by grass. W. G. Smith [4] mentions the practice as being used in southern Scotland with a view to increasing the flush grassland.

At Boghall heather is limited in area and mostly high lying, being above the level at which springs emerge on the hill-slopes, and thus outwith the scope of treatment by flushing. The flushing experiments have been designed, therefore, rather with a view to the improvement of some of the inferior types of grassy herbage.

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[1] Robertson, Jas., D.D., "General View of the Agriculture in the County of Perth," 1799.

[2] Smith, J., "On the Advantages of Watering Pasture and Meadow Grounds in the Highlands." *Trans. High. and Agric. Soc.*, *Scotland*, Ser. i., vol. i., 1799.

[3] Robie, D., "On English Water Meadows and how Far they are Applicable to Scotland." *Trans. High. and Agric. Soc.*, *Scotland*, Ser. iv., vol. viii., 1876.

[4] Smith, W. G., "The Improvement of Hill Pasture." *Scot. Jour. Agric.*, vol. i., No. 3, 1918.

The method used is to block the channel by which the water runs away and to carry it by means of a shallow trench along the contour of the slope which it is proposed to flush. The water runs down over the surface from the end of the lade, which is from time to time extended so as to carry the flush water on to a new part.

The first visible effect of flushing is seen in a fresh growth of young grass shoots. This is naturally most marked at those times of the year when growth is most active, but even in winter the grass responds to watering by the production of new growth. The succulent herbage thus produced is attractive to sheep, and the animals soon discover and graze the watered area. This intensified grazing continues even after the flush water has been carried farther along the slope. The rough tufts are gradually reduced and a permanent improvement results. The contrast in grazing between flushed and unflushed ground is especially noticeable about the end of summer, when the flushed ground stands out conspicuously on account of its fresh green appearance and the comparative absence of earing grasses, in contrast to the brown, burned appearance of the unflushed with abundance of ungrazed, dead and whitening ears.

Botanical changes in the herbage follow, the nature of which depends in the first instance upon the character of the original turf, the first species to react being naturally those which were present before irrigation was begun. Later on, however, new species may invade the area and spread rapidly, altering altogether the character of the vegetation. Broadly speaking, white clover and the broad-leaved grasses (including red fescue) characteristic of flush pasture, are encouraged by the treatment, while the bristle-leaved grasses, moss, and miscellaneous weeds, such as heath bedstraw, are reduced. A noteworthy feature is the increase in the total number of shoots of all species per unit area. Unflushed pasture frequently shows a dense turf, but this is in large measure due to the presence of a thick mat of dead plant remains, and the number of living green shoots, which alone are of value as food for stock, is comparatively small. Irrigation has the effect of promoting the vegetative activity of the plants, thus resulting in increased tillering of the grasses, which must in its turn result in an increased production of food for the sheep.

Very striking changes in the vegetation have been observed as the result of watering in the dry *Nardus*-blaeberry herbage. Springs are absent from this area at Boghall, and there is thus a scarcity of the basic spring water which it is desirable to employ for flushing purposes. The water used was probably derived at least in part from surface drainage from the hill-slopes above, and was low in bases. In spite of this, however, the character of the vegetation has undergone a very marked alteration and grazing has increased. *Nardus*, which was formerly dominant, has not been entirely eliminated, but is very distinctly less prominent than formerly, while blaeberry has been reduced from a position of co-dominance with *Nardus* almost to vanishing point. The broad-leaved grasses have invaded the irrigated ground strongly. Yorkshire fog is now abundant and bent shows a marked increase. A sedge (*Carex binervis*) has become more prominent, and is well grazed in winter, while recently white clover has begun to invade the ground and appears to be spreading.

One effect of the watering in this area has been to encourage the development of rushes, the heavy nature of the soil and the relatively flat topography tending to prevent the water from running away rapidly enough, and thus maintaining wet conditions favourable to their growth. This, however, could possibly be avoided by running the water off altogether at intervals and allowing the soil to dry. In this connection it is worthy of note that individual species which may be encouraged by flushing are not necessarily desirable plants. A case in point is that of nettles. In one instance these were markedly favoured by flushing and spread on to ground from which they had formerly been absent. Where flushing is carried on, therefore, it may become necessary to guard against the spread of such inferior grazing plants. Bracken has not shown any marked reaction to flushing at Boghall.

The effect of artificial flushing in combination with manuring has been tested in one case. The subject was a dry gravelly slope occupied by a rough herbage of sheep's fescue and bent, which had been invaded by a considerable amount of *Nardus*. The presence of the *Nardus* had reduced grazing and was in large measure responsible for the roughness of the herbage. Yorkshire fog and white clover were present locally in small quantity. A part of this area was manured in the spring of 1931 with ground mineral phosphate (30 per cent. P_2O_5) at the rate of 5 cwt. per acre, but in the course of a year showed very little improvement, although white clover showed a slight local increase and tended to spread somewhat into the rougher patches. During the following winter a flush was carried across part of the manured area, and in a very short time the result was seen in a decided improvement in grazing. In the course of the following season white clover spread considerably on the watered portion. While flushing tended to encourage the clover even where no manure was applied, the effect of combining the two treatments was much more marked in this respect. As regards grazing, however, there was little to choose between the manured and unmanured areas. Flushing by itself is much more effective than manuring in improving the grazing of this dry herbage.

Analyses of the soils from artificially flushed areas show that irrigation is responsible for bringing about very marked alterations in the soil. The most striking changes are in acidity and "lime requirement," both of which constantly show a very decided fall even after a comparatively short period of flushing. In respect of these two features the artificially irrigated soils correspond very closely with the naturally flushed soils of the "moist flush" and "wet flush" types. "Available" phosphate and "available" potash also show changes after flushing, the figures again tending to come more closely into line with those from naturally flushed soils. The soil changes induced by flushing thus correspond with the alterations which are observed to take place in the vegetation, the tendency in both cases being towards the production of a "flush" type.

The mechanism of this change is probably a complex one, involving, among other factors, alterations in the micro-biological activities in the soil. No investigations on these activities have been conducted in connection with the present experiments, but it is of interest to note that Hesselman[1] has shown that in soils flushed by fresh flowing water rich in dissolved oxygen nitrification proceeds actively. Also recent experiments in Wales[2] show that the supply of available nitrogen may be a strongly limiting factor to the improvement of hill pastures, an increased supply, if accompanied by sufficiently severe defoliation, either by shears or by sheep grazing, resulting in pronounced changes in the vegetation of a type somewhat similar to those induced by irrigation.

The heavier grazing which follows upon flushing is no doubt an important contributory factor in improving the herbage. The strong growth of coarse grasses such as *Nardus*, as well as Yorkshire fog, bent, etc., if ungrazed, has a most detrimental effect upon the turf. White clover and other fine bottom herbage are suppressed and a thick sod soon begins to develop. The removal of this coarse top growth by the harder grazing results in the production of a shorter, sweeter herbage, more attractive to stock and leafier and therefore more nutritious.

Burning and Cattle Grazing.—Reference has already been made to the low palatability to stock of *Nardus stricta*, particularly after late May to early June, when the flowering shoots of the plant develop rapidly and abundantly. These rough fibrous flowering shoots are totally neglected by sheep, and by the end of the summer they are dead and bleached. The dead stalks remain standing throughout the winter and considerably reduce the value of the winter grazing. Not only are they of no value as food in themselves, but they interfere with the grazing of such other plants as are associated with them. This can be well seen where scattered tufts of *Nardus* occur mixed with other vegetation; for example, where *Nardus* is invading a short bent-fescue herbage. The herbage between the *Nardus* tufts is frequently closely grazed, while the tufts themselves are coarse and untouched by the sheep. If one of these tufts is examined it will be found not to consist exclusively of *Nardus*, but also of much rough grass of the same species as are well grazed close by—bent, fescues, Yorkshire fog and the like. Thus the mere presence of *Nardus* suffices to reduce the utilisation of other better species, and when it is present in quantity the effective grazing area is considerably reduced. Unless steps are taken to remove the useless and unpalatable roughage, deterioration becomes progressive. Each year a fresh crop of flowering shoots is produced and dies, adding to the roughness and further reducing the grazing, while the lack of grazing in its turn has the effect of causing even the more valuable grasses to grow coarse and unpalatable.

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[1] Hesselman, H. "Studiën över Salpeterbildningen i Naturliga Jordmäner," Stockholm, 1917.

[2] Stapledon, R. G. "Improvement of Rough and Hill Grazings," *Jour. Min. Agric.*, xxxviii., 12, 1932.

The young shoots of *Nardus*, which are produced in spring, are much less fibrous and more palatable than the flowering shoots. Moreover, they develop at a relatively early date, from late March and early April onwards, and at this time may afford useful keep, provided they are not rendered inaccessible by a dense covering of last year's dead shoots. After a period of dry weather in the late winter or early spring the dried up dead material of the previous year's growth burns readily, and by burning at this time the old dead herbage can be to a large extent removed and the fresher young bottom growth both of *Nardus* and the associated undergrass exposed to grazing. Parts of the Glen have been burned in this way each year and observations have been made on the subsequent growth of the grasses and grazing by sheep.

The effects of spring burning on the herbage are very marked and are perceptible throughout the season. The most notable feature is the comparative failure of the grasses on the burned areas to produce flowering shoots, an effect attributable in part directly to the burning, but partly also to the closer grazing which follows burning. As a result, the grasses remain throughout the summer in a leafier and more palatable state, and grazing is thus encouraged. The contrast between burned and unburned areas is very striking in the late autumn and winter. The unburned parts are covered with white dead, flowering shoots, while the burned portions are comparatively free from these and pale green in colour. The result must be to render the more succulent green bottom growth much more accessible to grazing during the winter and early spring months, and thus to extend considerably the effective grazing area. Under ordinary conditions this effect lasts for a single season only. In the year following that in which burning is carried out, the *Nardus* flowers as usual and the herbage tends to become rough and neglected again. By burning in alternate years, however, it should be possible to keep *Nardus* pasture in a comparatively nutritious and productive condition.

The effect of burning is even more marked if it is followed by cattle grazing. Cattle are less selective in their grazing habits than are sheep and will graze comparatively rough herbage which sheep refuse to touch. During the last few years, a number of cattle have been run on Boghall hill during the summer, going on to the hill about May and remaining until October or November.

In 1931, a large area of rough "*Nardus* with undergrass" was burned in March, and in the early part of May eight Galloway cows and their calves were turned on to the hill. By this time the *Nardus* in the burned area was coming away well and the cattle grazed it hard. Since 1926, the glen has been divided into two sections by a fence, and, as it happened, the fence cut across part of the burned area, so that one section was grazed by sheep alone, while the other carried both cattle and sheep. The effect was seen in July when a marked difference was apparent between the herbage on the two sides of the fence. On the side where sheep only had been grazing, the grasses were earing and inclined to be rough, while on the other side few ears were visible and the roughness was much grazed down. Later on, when the cattle were transferred to the other side of the fence, the *Nardus* was already in ear and tended to be neglected in favour of other more palatable herbage ; this result indicates that in order to keep *Nardus* in good condition, it is necessary to graze it early in the season.

A similar improvement in the grazing of rough herbage is seen in the areas of " wet flush " pasture described above. The cattle have grazed down the rough grass which the sheep do not eat, a circumstance which cannot fail to improve the grazing value of the herbage by inducing a leafier growth and encouraging the finer bottom grass and white clover. The possibilities of improvement in this type of herbage by closer grazing were incidentally illustrated in connection with another experiment in which a small area was subjected to close cutting with shears every three weeks, being clipped six times during the growing season. At the beginning of the treatment the herbage was a rough little-grazed mixture of coarse grasses, *Nardus*, sweet vernal grass, sheep's fescue, Yorkshire fog, and bent, with admixture of sedges and other plants, and traces of white clover throughout, but suppressed by the strong top growth. When the rough grass was removed at the first cutting, much bare ground was exposed. Under the clipping, however, by June there was a noticeable spread of white clover, and by the end of the growing season it had spread over almost the whole plot. Coincidentally with this, the *Nardus* was markedly reduced and the plot, which had originally been of a coarse tufty nature, became altered to something in the nature of a close sward. Ordinary grazing does not approach this system of intensive cutting in severity and differs from it also, in the fact that, while clipping is non-selective in character, grazing is selective, some species being eaten back much more closely than others. The alteration in character of the frequently clipped plot does, however, serve to illustrate the importance of the grazing factor in the improvement of pasture. There is no doubt that harder grazing of these rougher herbage types, such as could be secured by grazing cattle, would result in the gradual removal of much of the roughness and the production of a finer herbage which would provide more keep for the sheep.

Summary.—1. An account is given of some types of semi-natural grassland occurring in Boghall Glen, and the associated soil conditions ; certain herbage types are shown to be associated with particular soil conditions.

2. Experiments with manures demonstrate that the most responsive herbages are those subject to flushing by hard spring waters ; certain types are unresponsive to manurial treatment, perhaps because of the absence of white clover and other superior herbage plants, the presence of a thick mat on the soil surface, and inadequate grazing by stock.

3. Artificial irrigation of unflushed ground with spring water leads to a marked improvement in grazing and to changes in the soil and the botanical character of the sward, white clover and broad-leaved grasses being favoured as against bristle-leaved grasses and heath plants.

4. Spring burning of *Nardus* greatly reduces the amount of flowering in the season following the burning and maintains the herbage in a more useful condition for stock.

5. Cattle will graze down rough herbage which sheep will not eat, thus improving the pasture.

SOME VIRUS DISEASES OF THE POTATO AND OTHER FARM CROPS

Kenneth M. Smith, D.Sc., Ph.D.

Potato Virus Research Station, School of Agriculture, Cambridge

What is a Virus?—In 1892 Iwanowski, a Russian botanist, found that the juice from tobacco plants showing a " mosaic " disease still retained the power of infecting healthy tobacco plants after it had been passed through a filter candle, the pores or holes of which were too fine to allow any microscopic organisms to pass. This was the first discovery of a " virus disease."

The " filterable viruses " then—so-called because of their capacity to pass through these very fine filters—may be defined as exceedingly minute disease-producing agents which are in general below the borderline of microscopical visibility. It cannot be said, at present, whether viruses are " alive " in the ordinary sense of that word, though they show some of the characteristics of living things. It is possible that a virus may be of a more simple unorganized nature, something like the " growth-promoting " substances of tissue cells which stimulate the cells to produce more of such substances. It is more probable, however, that viruses are particulate in nature and may be likened to excessively minute bacteria. Whatever they may be, there is no doubt that these mysterious agents are responsible for some of the most devastating diseases which affect mankind, his live stock and his crops.

Some Common Virus Diseases in Animals and Plants.—Hardly any type of living organism is exempt from attack by viruses. Man, domestic animals, birds, fish, insects, plants of all kinds and even bacteria themselves are all subject to this type of disease. Such well-known diseases as smallpox, yellow fever and mumps are examples of viruses affecting man, while foot-and-mouth disease and dog distemper are similar affections of animals. Fowl-plague, fowl-pox and psittacosis are virus diseases of birds; "sac-brood" of bees and "caterpillar wilt" are similar disorders of insects, while bacteria are subject to attack by a group of virus-like entities known collectively as "the bacteriophage."

The plant viruses form a large and important group of disease-producing agents, and it is with those viruses which affect especially crops of economic importance that this article is chiefly concerned.

Relationship of Plant Viruses with Insects.—The classic case of disease transmission by an insect is that of the malarial organism and its vector, the Anopheles mosquito. Certain virus diseases of man are spread in a similar manner, as, for example, yellow fever by the mosquito *Stegomyia fasciata* and trench fever by the body louse *Pediculus corporis*. This insect association, however, is developed to its highest degree in the plant viruses and many such diseases are entirely dependent upon insects for their dissemination in the field.

The relationship existing between the virus and the insect is not merely a passive mechanical carrying of the one by the other, although such a state of affairs may exist. There appear to be varying degrees in the closeness of the relationship. There is first the virus which depends entirely upon a single species of insect for its transmission, and which can be spread by no other insect. An example of this kind of association is the "curly top" disease of sugar-beet in North America which is spread only by one particular species of leaf-hopper, *Eutettix tenellus*. An intermediate case of a partial affinity between an insect and a plant virus is afforded by potato leaf-roll (see Fig. 5). This is disseminated with great efficiency by one species of greenfly (*Myzus persicæ*; see Fig. 3), less efficiently by one or two other species of greenfly, and not at all by other types of insects which feed upon the potato. A purely passive mechanical relationship between plant virus and insect is thought to exist in certain cases such as cucumber mosaic and an American potato disease known as "spindle tuber," where the viruses can be disseminated by a number of insects of different kinds.

Plant-feeding insects may be divided into two groups, biting- and sucking-insects, according to their method of feeding. The method of feeding seems to be a determining factor in the spread of viruses by insects, for whereas a large number of viruses are disseminated by sucking-insects, it is exceptional for them to be spread by biting-insects. Beetles or caterpillars are examples of the last group, while examples of sucking-insects are greenflies and capsid bugs. These insects feed by means of a long sucking tube inserted into the plant tissue. It is the sucking-insects that are chiefly concerned with the spread of plant viruses, and their method of feeding must be examined a little more closely in order to understand how infection with the virus is brought about. Insects belonging to the order Hemiptera, which includes the plant-sucking group such as aphides, leaf-hoppers, capsid bugs, etc., possess a long beak or proboscis (the labium) which encloses two pairs of delicate needle-like stylets (the mandibles and maxillæ). In feeding, the insect presses the tip of the labium on the leaf surface, usually the underside. In so doing the labium bends, becomes foreshortened and the fine stylets are driven into the plant tissue. The beak (labium) does not enter the tissue. The stylets each possess a groove on the inner face which, when apposed to one another, form two channels down one of which flows the saliva, mixing with the sap in the plant cells, and up the other flows a mixture of sap and saliva drawn up by means of the muscular pump situated in the head. Fig. 1 is a photomicrograph of a section of potato leaf showing the labium of the aphis *M. persicæ* in position. The stylets are just

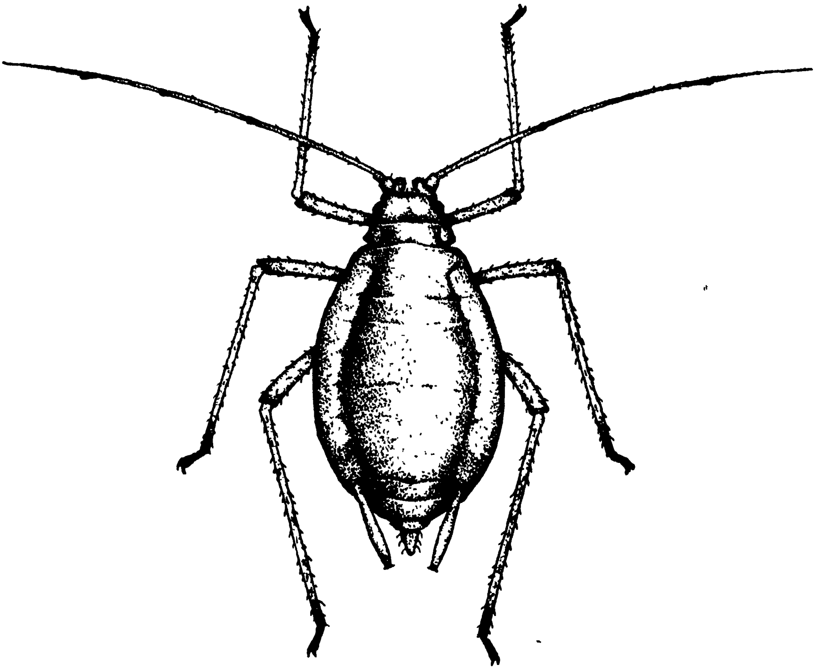

FIG. 3.—Potato aphis. (*Myzus persicae,* Sulz.) Wingless female.
This insect is the chief vector of potato viruses.

about to enter the leaf tissue through a stoma and tap the phlœm which lies just below.

The saliva of the insect is thought to be the means by which the virus agent is introduced into the healthy plant. After feeding upon a virus-diseased plant the saliva becomes contaminated with the virus particles and these are injected into the next healthy plant during the normal process of feeding.

It has been found that infective insect vectors of certain virus diseases are able to remain infective to healthy plants for long periods, sometimes for the rest of their lives. In other words, having once fed upon a virus-diseased plant, they continue to be able to transmit the virus to healthy plants without having to replenish their supply of virus by feeding once more on the diseased plant. This would seem to show that the virus continues to multiply within the body of the insect. Such a state of affairs exists in regard to the virus of potato leaf-roll and the insect vector *Myzus persicæ* (see Figs. 5 and 3).

It is a characteristic of viruses as a whole that they must be brought into contact with the *living* cell in order to fulfil the necessary conditions for their multiplication. This fact is thought to be one reason why a certain large group of plant-sucking insects, the capsid bugs, appears unable to disseminate plant viruses. The saliva of these insects is itself toxic to plant life and each puncture made in the leaf of the host is marked by a patch of dead cells. A common condition of potato plants, known as " stung " in some parts of the country, is due to the feeding of these capsid bugs and has no connection with virus diseases.

Although the saliva of a proved insect vector of plant diseases, such as the aphis *Myzus persicæ,* is not poisonous to the plant, it is possible by a special process of microscopical technique to pick out the track left in the plant tissue by the stylets. This can be seen in Fig. 2, which is part of a transverse section through a potato stem which has been punctured by this aphis. The path taken by the stylets of the insect can be plainly seen, passing between the cells and reaching down to the phlœm elements of the vascular bundles.

It will be realized from this very short account of the methods by which plant viruses are thought to be carried by insects, that the aphis *M. persicæ* is really a very suitable type of insect for the spread of this kind of disease agent because it introduces the virus, with the minimum of disturbance to the host cells, to the phlœm of the vascular bundles, a region suitable both for the multiplication of a supposed organism and for its ready dispersal to other parts of the plant. This same insect *M. persicæ* is concerned in different parts of the world with the transmission of no less than thirteen distinct plant viruses.

Some Common Virus Diseases of Crops.—Viruses appear to penetrate all the vegetative organs of a plant, but only rarely do they enter the true seed. It is on account of this fact that virus diseases are of much greater economic importance in plants, such as the potato, which are carried on from year to year in a vegetative manner.

The crops of economic importance most frequently attacked by virus diseases in the British Isles are the following: Hops, raspberries, strawberries, sugar-beet and mangolds, tomatoes and potatoes. The hop plant is very prone to attack by one or more viruses of the " mosaic " type which in this particular host seem to be of an unusually virulent character. Although hop mosaic is of considerable economic importance and causes much loss to the grower, there is no information regarding the insects which are responsible for spreading it in the hop gardens.

Raspberries and strawberries are frequently attacked by mosaic diseases, and in some districts strawberry plants appear to be reaching a stage of degeneration, due apparently to virus infections, which can be paralleled only in some English potato stocks. A mosaic disease is very prevalent in sugar-beet and mangold crops, and this virus is transmitted by the aphis *Myzus persicæ* (see Fig. 3).

There are several viruses which attack the tomato plant, and one of these deserves special mention. This is known as " spotted wilt " of tomatoes and appears to have become established only recently in the British Isles, where it is now causing concern among tomato growers. The first sign of the disease is the development of a characteristic bronzing of the younger leaves of the tomato. This is followed by a slowing of growth and the later development of a yellowish mosaic on the leaves. Such plants are of no value and should be at once removed and burned, as, if left, they act as further sources of infection. Tomato spotted wilt differs from the potato virus diseases in its mode of dissemination. The insect vector is not an aphis, but a minute insect known as a thrips (*Thrips tabaci*) which occurs commonly in glasshouses all over the country. Another point of difference from the potato viruses is the ability of the spotted wilt virus to attack plants of many different kinds. Most of the ornamental plants which are grown alongside of tomatoes in " mixed houses " are susceptible to infection by the spotted wilt virus, and this fact is of importance as it enables the virus to " carry over " the periods intervening between the tomato crops. It may perhaps be worth while recording, for the benefit of tomato growers, those plants which are susceptible to the spotted wilt virus. Such plants should not be grown in proximity to tomatoes in spotted wilt areas. They are as follows: Dahlias, nasturtiums, lupins, cinerareas, asters, zinnias, *Solanum capsicastrum*, Iceland poppies and chrysanthemum. In addition the virus will attack all members of the Solanaceæ and certain weeds such as the plantain and bindweed (*Polygonum*).

Potato Viruses and Virus Disease.—The potato crop is of great importance to Scottish agriculturists, and as it is one which is frequently affected by viruses, the remainder of this article will be devoted to a description of potato virus diseases and their mode of dissemination.

Not so many years ago it was thought that there were only two potato viruses, and these were known as potato *leaf-roll* (or leaf-curl as it was first called) and potato *mosaic.* Potato *crinkle* was considered to be a severe form of potato mosaic. Now it is known that there are six or seven potato viruses of the mosaic group, although it cannot definitely be said that some of these are not mutations or variations from other viruses. The existence of this large number of viruses and their occurrence in the field in different combinations have given rise to the confusion at present existing in the study of this difficult group of viruses.

In discussing, then, the question of the virus diseases of the potato, it is proposed first to describe the more common diseases caused by single viruses and then to deal with a disorder, frequently met with, which is due to two viruses acting together.

Potato Leaf-Roll.—Leaf-roll is one of the few potato virus diseases which can be recognized as such with a fair degree of certainty on any potato variety, and so far as present knowledge goes it is caused by a single virus. There are two phases in the development of the disease, known respectively as *primary* and *secondary* leaf-roll. Primary leaf-roll consists of a rolling of the edges in the upper young leaves only of the plant. This phase is transitory in some varieties and, if the plant is infected late in the season, may never develop. In such a case of late infection it is common for no symptoms to appear in the current year, but the tubers give rise in the following season to plants showing secondary leaf-roll. In this condition the lower leaves as well as the upper ones are rolled, the whole plant is stunted and the leaves are thickened and harsh to the touch (see Fig. 5). The rolling is due to large accumulations of starch in the leaf blades. In addition to the rolling there is a general pallor of the leaf together with a development of pigment at the leaf bases, purplish in colour in some varieties, yellowish in others.

Potato varieties differ somewhat in the degree of rolling exhibited by the leaves. In varieties Edzell Blue, Arran Victory and British Queen, the rolling is fairly pronounced (see Fig. 5), but in President the rolling is less marked while the leaves take on an upright habit. This last variety is exceedingly susceptible to leaf-roll and, largely for this reason, has fallen out of cultivation. The variety Great Scot does not show very pronounced rolling, but the leaves take on a characteristic pallor and appear stiffer than normal.

The virus of potato leaf-roll cannot be transmitted to a healthy plant by inoculation, that is by rubbing the leaves of the healthy plant with virus-containing sap. It is dependent upon two species of aphides or greenfly for its transfer in the field. One of these two aphides is much more important than the other in this respect and possesses a special affinity for the leaf-roll virus. This is *Myzus* *persicæ* (see Fig. 3), and it transmits the disease with very great efficiency. The other species of aphis which is capable of acting as a vector is *Myzus pseudosolani*. It is rather similar in appearance to the foregoing, but can be recognized by its longer legs, its colour of a darker green and the straight cylindrical siphons (cornicles). In *M. persicæ* these latter are somewhat swollen as shown in the figure. In the writer's opinion these two aphides are the only insects which are concerned in nature with the spread of potato leaf-roll. There are one or two other aphides which are capable of transmitting the disease under experimental conditions, but they are confined to glasshouses and do not ordinarily occur in the field.

In addition to the risk of infection with leaf-roll incurred by the plant in the open field, there is a second opportunity for virus transmission afforded to the insect when the " seed " tubers are sprouting in the trays. Both *M. persicæ* and *M. pseudosolani*, but especially the latter, are commonly found feeding on the sprouts of tubers, and infection can be conveyed by this method even more readily than to the growing plant. It is worth while, therefore, to fumigate the storehouse by vaporizing some nicotine in a metal saucer over a spirit-lamp at weekly intervals after the tubers have commenced to sprout.

A few other plants are susceptible to infection with the leaf-roll virus, notably the black nightshade (*Solanum nigrum*) and a less common weed, the thorn apple (*Datura stramonium*).

Potato Mosaic Viruses.—As it is not possible in the space available to deal adequately with all the potato mosaic viruses, only those most commonly met with will be described.

Potato virus workers are now endeavouring to devise a method of naming each *virus*, as it is isolated, by some symbol, such as a letter of the alphabet, to take the place of the old system of nomenclature whereby the *disease* was known as mosaic, crinkle, crinkle-mosaic, stipple-streak and so on. These diseases were in most cases complexes of more than one virus which changed their appearance according to the variety of potato affected and according to the method of disease transmission which was used. Much of the confusion now existing in the knowledge of these diseases is due to this system of naming the *disease* and not the *virus* which causes it.

Potato Virus " X ".—This mosaic virus, called " X " by the present writer, is extremely common among potatoes both in England and in Scotland. The diseases caused by this virus on a number of potato varieties are given as follows : on Epicure, Arran Crest, and King Edward it produces a destructive disease commencing at the topmost leaves and growing points and ultimately killing the whole plant. On Arran Victory and President the symptoms take the form of a mild mosaic mottling without killing the cells, while on Eclipse it produces a more pronounced mottling. The varieties Up-to-Date and Di Vernon are " carriers " of the " X " virus ; that is to say they show no symptoms of disease when this virus is present

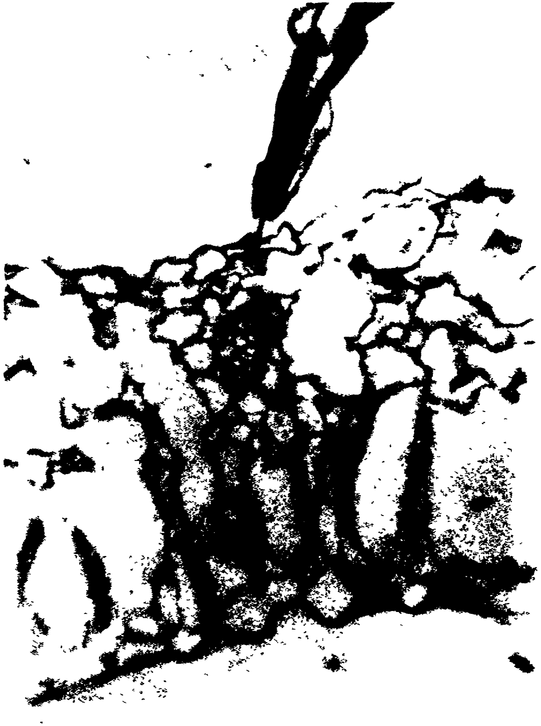

FIG. 1.—Photomicrograph of a section of potato leaf with the beak of the aphis, *Myzus persicae*, in position. The stylets can be seen about to enter the leaf tissue through a stoma and tap the phloem which lies just below. X 640.

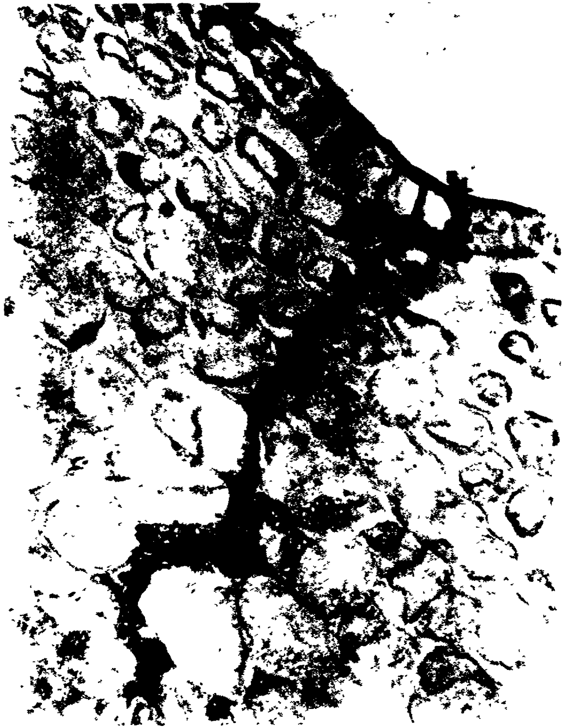

FIG. 2.—Photomicrograph of a section of potato stem which has been punctured by the aphis, *Myzus persicae*. The track left in the tissue by the saliva of the insect has been picked out by staining and can be clearly seen. X 800.

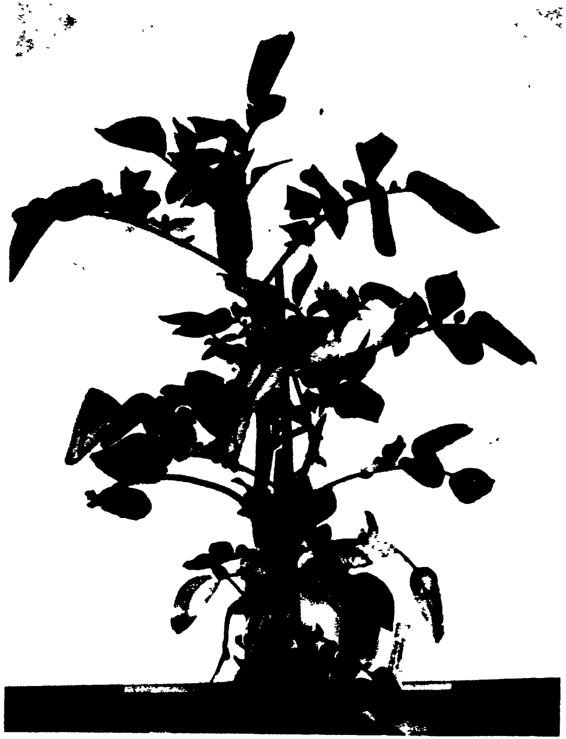

FIG. 5.—Potato leaf roll (var. British Queen).

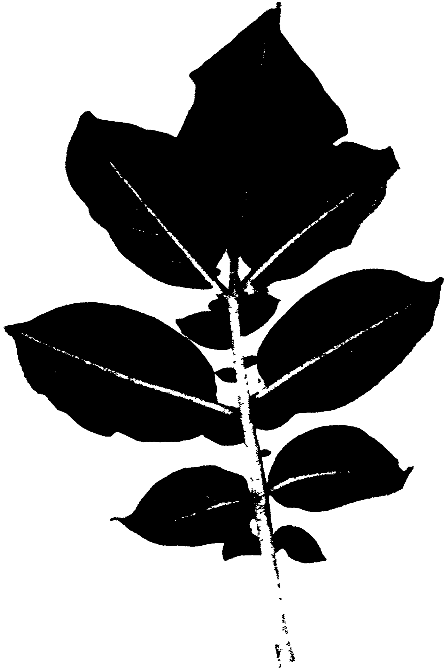

FIG. 6.—Potato virus Y (var. Up-to-date). Primary symptoms of infection. Note the brown spots (lesions) developing on the under surface of the leaves.

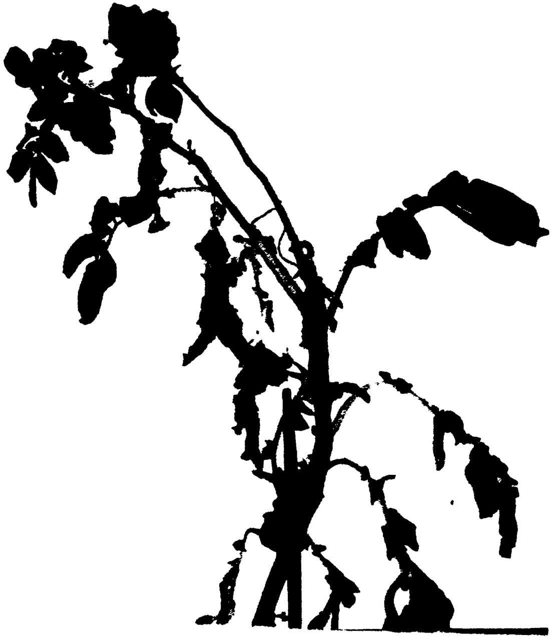

Fig. 7.—Potato virus Y (var. Eclipse). Secondary or systemic infection. Note the leaf-drop effect.

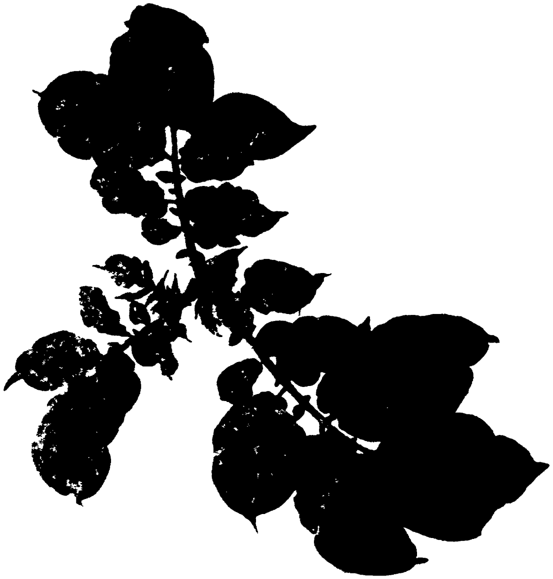

Fig. 8.—Murphy's crinkle (var. President). This disease is due to the action of two viruses, A+X.

in the sap of the plant. This fact can easily be demonstrated by grafting a shoot of one such carrier plant on to a healthy stock of Epicure, for example, when the disease characteristic of the "X" virus on that variety will develop.

Although the "X" virus is so common in many potato varieties, it is not yet known by what means this virus is spread in the field. All the common insect fauna of the potato plant have been tested at Cambridge, but so far all have failed to infect healthy plants with this virus. It seems clear that the greenflies usually concerned with the transmission of other potato viruses are unable to transmit virus "X".

Potato Virus "Y".—This virus is responsible for the potato diseases known in earlier days as leaf-drop-streak, stipple-streak, or simply streak. It is one of the commonest and most destructive of the potato viruses in England, but occurs much less frequently in Scotland. It is undoubtedly this and the leaf-roll virus which are responsible for the greater part of the degeneration of potato crops. The chief symptom picture is that of leaf-drop-streak which it produces in the current season on the varieties President, British Queen, Up-to-Date, Majestic, Arran Consul, King George, Duke of York, Eclipse and many others (Fig. 7). The first symptom is the appearance of a blotchy mottle spreading from the veins and affecting the uppermost leaves only. This mottle later becomes intensified and is accompanied by some wrinkling and waving of the leaves. A little later brown spots appear on the undersides of the veins of leaves occupying an intermediate position of the stem (Fig. 6). These spots or necroses increase in size and pass down the petiole to the main stem; the leaves then collapse and rapidly wither, and finally remain hanging attached to the stem (Fig. 7). On Arran Victory, Epicure and Arran Chief the symptoms are only those of a mild mosaic mottling. Di Vernon often carries virus "Y" without symptoms.

The disease due to the "Y" virus has been very prevalent in the potato crops round Cambridge in the present season, and parts of affected fields present an appearance reminiscent of bad attacks of potato "blight." Virus "Y" is carried with great efficiency by the aphis *Myzus persicæ* (Fig. 3), and when, as in the present season, this insect is prevalent the virus is spread with great rapidity among the potato crops.

Various other plants allied to the potato are susceptible to infection with the "Y" virus—*e.g.* black nightshade (*Solanum nigrum*), henbane (*Hyoscyamus niger*) and the tomato. If these plants are growing in the vicinity of potato fields they are almost invariably infected, and one of them, the black nightshade, carries the virus without exhibiting any disease symptoms.

Potato Virus "A".—Another virus has recently been isolated by Murphy and M'Kay in Ireland which they have named virus "A". This virus occurs commonly in the variety Irish Chieftain, on which it produces few or no symptoms. A faint mosaic mottle accompanied by a slight waving of the leaf margins may sometimes be seen in young plants under glass. On the varieties President and Arran Victory the symptoms are a faint mosaic. Virus " A " has some of the characteristics of the " Y " virus and is considered by the Irish workers to belong to a " Y " group. They also state that it is transmitted by the aphis *Myzus persicæ*.

The chief importance of virus " A " to the potato grower lies in its power to form a severe disease when it is present in certain potato varieties together with another common potato virus, the "X" virus. This disease is called crinkle, and is discussed later.

Paracrinkle.—This virus, for which the symbol "E" has been suggested, was first described and isolated by Salaman and Le Pelley, and was so named to differentiate it from Murphy's crinkle which, as already indicated, is a disease due to the action of two viruses. Paracrinkle occurs in nature only in the variety King Edward, which carries the virus perfectly. It appears to be present in all commercial stocks of King Edward without in any way affecting the health or cropping power of the variety. If a scion from King Edward be grafted to Arran Victory plants, these develop a severe disease in which the leaves are deformed and there is much crinkling and distortion. Tubers from these plants if grown in the field produce a rosetted plant of the " curly dwarf " type about 6-9 inches high.

Not very much is known about this interesting disease. There is no evidence that it is caused by more than one virus and the insect vectors are not known. So far the virus has been transmitted only by grafting and has probably been seen only upon the potato plant. It does not appear to spread to other potato varieties in the field.

Potato Virus Complexes.—Owing to the wide distribution of the "X" virus among English potato stocks and the ease and rapidity with which the " Y " virus is spread about by the aphis *Myzus persicæ*, it will readily be understood that a potato virus disease in the field is usually a " mixed infection " of at least two, and sometimes more, viruses. Murphy and M'Kay have shown that their specific crinkle disease is a composite one consisting of viruses "A" and "X" ("X"=Murphy's simple mosaic). The typical symptom picture exhibited by the "A"+"X" viruses is shown in Fig. 8 which is an illustration of Murphy's crinkle on potato President. Affected plants are bushy and dwarfed, the most characteristic symptom being a pronounced puckering and downward curving of the leaves. Diffuse yellowish areas occur all over the foliage, and as the plant matures rusty brown spots develop on the leaves.

There are other types of crinkle which differ slightly in their symptoms from the foregoing. The variety Myatt's Ashleaf is very frequently affected with a crinkle disease. This also is composite in nature and is due to the action of the two viruses "X" and "Y". It is probable that this disease is the same as that known in America as " rugose mosaic."

As already pointed out in dealing with potato virus " X ", it is not known how this virus is transmitted in the field, and it does not appear to be carried by the aphis. Presumably, therefore, these composite diseases are not transmitted *as such* but arise from the introduction of the " Y " or " A " viruses into a plant already infected with the " X " virus.

Potato Aphides.—There are four species of aphides or greenfly

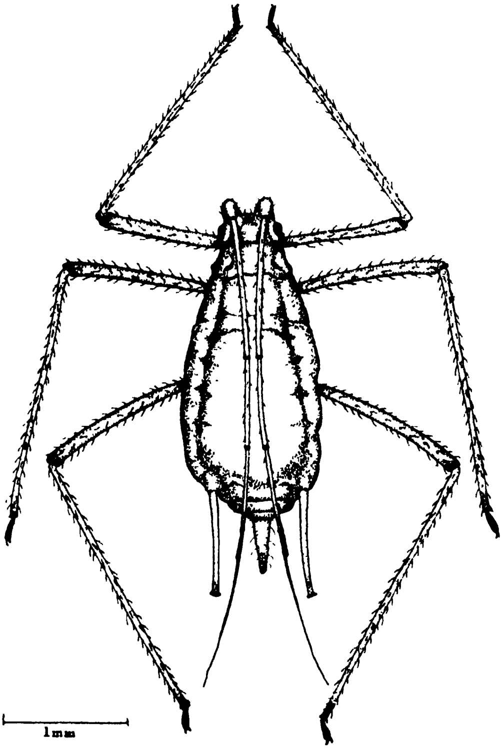

Fig. 4.—Potato aphis. (*Macrosiphum gei*, Theob.) Wingless female. It is doubtful if this insect transmits potato viruses.

which usually attack the potato plant in England and the two most common of these are illustrated in Figs. 3 and 4. *Myzus persicae*, the smaller of the two, is the aphis which is responsible for most of the potato virus transmission. The other species, *Macrosiphum gei*, illustrated in Fig. 4, is a larger insect and can be recognized by its long straight cornicles which are reticulate or net-like at their extremities. The young forms are mealy in appearance. Although this insect is considered by workers abroad to transmit potato viruses, it has consistently failed to do so in experiments at Cambridge and, in the writer's opinion, is of no importance as an agent of potato virus transmission.

The other two potato aphides are *Myzus pseudosolani* which can act as an occasional vector of potato leaf roll, and a small yellow-green aphis, *Aphis rhamni*, which does not appear to be a vector of potato viruses.

Potato Aphides in Scotland.—It is an interesting point that the "X" virus, which is not aphis-transmitted, appears to be common in Scotch potato "seed" while the "Y" virus which depends upon the aphis *Myzus persicae* for its spread in the field is less commonly found in the Scotch potato stocks. Can this fact, and also the small amount of spread of potato viruses generally in Scotland, be correlated with an absence or scarcity in that country of the aphis vector, *Myzus persicae*? A survey of the aphis population of the potato crops in Scotch "seed" potato areas was commenced in 1931 by the writer's colleague, Mr J. P. Doncaster, but it had to be discontinued owing to financial stringency. It may be worth while recording his preliminary notes. The aphis *M. persicae* was found in small numbers on experimental plots at Corstorphine, Edinburgh. Similar small infestations of aphides were observed in "seed" growing (Epicure) areas in Ayrshire. Here, however, the chief species was *Macrosiphum gei* and very few specimens of *M. persicae* were observed. Three days' observations in Aberdeenshire (Huntly and Aberdeen district) revealed no aphis infestation on potatoes whatever. So far as these observations go, therefore, they indicate a scarcity of the virus-transmitting aphis, *M. persicae*, in the Scotch "seed" potato districts.

Acknowledgment is due to Mr F. C. Bawden and Mr J. P. Doncaster for taking some of the photographs illustrating this article and to Mr Doncaster for making the drawings of the aphides. Fig. 2 is reproduced with the permission of the Editors of the *Annals of Applied Biology*.

KALE AS A SUBSTITUTE FOR SWEDES, TURNIPS AND MANGOLDS

H. G. Miller, B.Sc.

Rothamsted Experimental Station

The popularity of kale, at least in England, is steadily increasing; but since the annual agricultural returns give no separate figure for the acreage under this crop, the extent of this increase, though noticeable to any observer, cannot be stated in figures. Probably the chief reason for the increase is to be found in the farmer's desire for a suitable root crop for stock which can be grown with a minimum of expense in labour. Kale may have fewer attractions where labour is naturally efficient or plentiful, or where the farmer successfully fights unfavourable labour conditions by paying at piece-work rates for as many as possible of the jobs on a farm. There are, however, other noteworthy features of the crop, and an attempt is made to collect them here.

In comparing our different root-crops it is surprising to find how many gaps still exist in our knowledge of their characteristics. In view of this, much of what follows is more suggestive than conclusive and will no doubt require modification when more information becomes available. Root crops for stock feeding are still an important feature of British, and particularly Scottish, agriculture, and, in many districts, are likely to continue so. Thus gaps in our knowledge of these crops, and particularly of possible new types, should be filled as quickly as possible.

Any discussion of the place of roots in the economy of the farm raises many points, not only as to their effect on soil conditions and fertility, weed control, the yield of following crops, and the distribution of labour requirements, but also as to their cash value as a crop. It is by no means certain whether this can be accurately measured purely on the basis of the starch equivalent and protein equivalent values of the different types of roots. From work that has been done on cows by Boutflour, and on store and fattening cattle, and sheep, at Glasgow, Edinburgh, Aberdeen, Leeds and elsewhere, there is evidence to suggest that the value of roots varies with different classes and ages of stock, but there are as yet insufficient data from which to draw reasonably accurate conclusions. The comparisons given below between the different root crops are made only on the starch equivalent and protein equivalent basis.

Origin and Types of Kale.—According to the Encyclopædia of Scientific Agriculture, kale in the form of thousandhead kale has been cultivated as a fodder crop for very many years, but "was introduced first to general notice in 1876 by a farmer named Robert Russell." The kales are commonly supposed to be descended from the wild cabbage (*Brassica oleracea*) but there is no direct supporting evidence. Thousandhead kale probably arose[1] "as a selection from the tree-cabbage, or Jersey kale, which is a giant among kale, rising several feet high, and is grown mainly for its sprouts."

The two types of kale of chief importance to the farmer are thousandhead and marrowstem. The latter is the result of crossing kohl-rabi and thousandhead kale, and may be either green-stemmed or purple-stemmed, the former being the more popular. There is no definite evidence that one is more hardy than the other. The principal difference between thousandhead and marrowstem kales is indicated by their names, but the two are difficult to distinguish, at least up to the end of February, when grown unthinned; only those plants at the ends of drills or at thin places in the drill then show the characteristic differences.

Thousandhead is supposed to have a lower yielding-power and a higher resistance to frost than marrowstem, but as yet there are no reliable data giving a measure of these differences. From observation marrowstem seems sufficiently frost-hardy for most conditions in this country. In the last three winters while it has been grown at Rothamsted, it has resisted numerous sharp spells of frost, some lasting without a break for from ten days to a fortnight, with the loss only of the lower leaves.

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[1] *Farm Crops*, ii., p. 185, Gresham Publishing Co.

With other roots, there are numerous varieties to choose from, but so little breeding work has been done that there is nothing corresponding to this in kale. There is greater variation between individual plants in a field of kale, particularly with new types like rape-kale, than in a field of swedes or mangolds. There should therefore be profitable scope for the plant-breeder.

Attempts, still in progress, have been made to produce a new type of kale which, sown in the summer or early autumn, will be frost-resistant, yield well the following spring and break into flower later than marrowstem or thousandhead ; but so far these attempts, chiefly the result of crossing rape and kale, have been only partially successful and cannot be generally recommended.

Composition of Root Crops.—The feeding value of kale (including leaves), as determined by conventional methods, compares very favourably with that of other roots (ignoring tops), as the following table, derived from the Ministry of Agriculture's *Rations for Livestock* shows :—

	Dry Matter	Total Protein	Fibre	Starch Equivalent	Protein Equivalent
Marrowstem Kale .	14·3	2·4	3·8	8·9	1·3
Mangolds (yellow globe or tankard) . .	13·2	1·2	0·8	6·8	0·4
Swedes . . .	11·5	1·3	1·2	7·3	0·7
Turnips . . .	8·5	1·0	0·9	4·4	0·4

Taking the starch equivalent and protein equivalent of swedes as 100, those of the other crops are as follows :—

	S.E.	P.E.
Kale (whole plant) . .	122	186
Mangolds (roots) . . .	93	57
Turnips (roots) . . .	60	57

The feeding value of roots, as is well known, varies with the district but there is a great dearth of figures. These figures, not even true for all English districts, may need modification for Scottish conditions, particularly for turnips. The high nitrogen content of kale deserves emphasis.

Relative Yields.—There is a complete absence of accurate data showing the relative productivity of different root crops under similar conditions. Such knowledge as we possess, showing when turnips or mangolds, say, are preferred to swedes, is the result of the slowly gathered practical experience of farmers. Information about kale must be acquired more quickly. Crops of other roots exceeding 40 tons per acre are frequently reported and one wonders if, under these conditions, kale could give as high a yield, because there are as yet few, if any, published records of kale crops exceeding 30 tons per acre. The farmer generally overestimates its yielding capacity. A 28-ton crop looks remarkably heavy; it may even show signs of lodging.

Assuming for the moment that a given set of climatic and soil conditions will result in a 20-ton yield of each of the crops under discussion, the next table shows roughly their relative values—

	Cwt. per Acre Dry Matter	S.E.	P.E.	Food Value in Cash with S.E. at 6/3½ and P.E. at 9/6 per cwt.[1]
Kale (whole plant) .	57·2	35·6	5·2	£13 13 0
Mangolds (roots) . .	52·8	27·2	1·6	9 6 0
Swedes (roots) . .	46·0	29·2	2·8	10 10 0
Turnips (roots) . .	34·0	17·6	1·6	6 6 0

If leaves of the last three are left on the ground, their manurial values must be borne in mind. According to Warington's tables and the present prices of fertilizers, these would be something like 16s. for swedes and 26s. for turnips and mangolds. Obviously these figures would show wide variation, but kale would always show the superior cash value. The feeding value of Scottish swedes is scarcely likely to be so much greater as to bring their value up to that of kale, that is, on the equal crop weight basis.

Response to Fertilizers.—(1) *Potash and Phosphate.*—Anything like a full comparison between the four crops is still impossible because of our fragmentary knowledge. The situation is least satisfactory as regards potash and phosphate, because response to these fertilizers varies so greatly with the soil, season and the farmer's methods. We have figures, however, produced by Warington many years ago, with which more recent figures, chiefly of German origin, are in quite reasonable agreement, as to the amounts each of these crops removes from the soil, again assuming a 20-ton crop. At best, however, they serve only as a very rough guide. There is some evidence that rather higher figures may be more usual than those marked [a] in the following table.

	lb. removed by 20 ton crop.		
	Nitrogen	Phosphoric Acid	Potash
Cabbage [2] . .	134	46[a]	44[a]
Mangolds (roots) .	79	31	202
Swedes (roots) .	100	24[a]	90[a]
Turnips (roots) .	74	26	128

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[1] The figures given in *Jour. Min. Agric.*, July 1933, p. 383.

[2] No figures given for kale.

Kale is almost certainly less responsive to potash than mangolds, and from these figures may even require less than swedes and turnips. Swedes respond so well to phosphate that it is doubtful whether kale would be their equal. It would be well worth while in order to obtain reliable information on these questions, to arrange a number of accurate fertilizer trials at various centres, then it might be possible to form estimates of the average increase in yield to be expected from additional units of phosphatic and potassic fertilizers. Each experiment would require to be laid out like a variety trial, substituting for varieties the two chief root crops of the district and kale. Much work has of course been done on the manuring of root crops, as, for instance at Rothamsted and in North Wales, on swedes and turnips in Scotland and on the need of swedes for phosphate in Northern Ireland [1]; but the work at different centres has been disconnected and has not been conducted under comparable conditions.

(2) *Nitrogen.*—Here we are on more certain ground. The action of nitrogen is more universal—though again affected by the season and general level of fertility—and it has been studied in more experiments, some of the best of them quite recently.

From the Rothamsted experiments, Sir John Russell considers that we can reasonably expect an increase of 30 cwt. of mangolds in return for 1 cwt. of sulphate of ammonia. The same figure was obtained as the mean of 28 experiments in North Wales under conditions of much higher rainfall. But Jealott's Hill results give a figure of 51 cwt., a figure supported by Woburn results and by figures which are the mean of four year's experiments at the Midland College.

With swedes there is less information. An increase of 20 cwt. for 1 cwt. of sulphate of ammonia is expected at Rothamsted, but this is almost certainly too low for Scotland. Swedes are less responsive to larger quantities of nitrogen than is kale.

So far as is known, there are no reliable figures for turnips.

The information concerning marrowstem kale is summarised below in tons per acre. In each case there was sufficient potash and phosphate and at both Jealott's Hill and the Midland College, a dressing of dung each year. All these experiments were properly replicated and are set out in some detail to give an idea of the variation in response that one may expect with different conditions and seasons. Full details of the experiments at Woburn, of those in cooperation with the Midland College, and of those on kale cultivation at Rothamsted, will be found in the Rothamsted Annual Reports for 1931 and 1932.

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[1] See "Artificial Fertilizers," *Bulletin* 28, Ministry of Agriculture.

Centre	Year	Manure	Cwt. of manure used							Increase in cwt. per cwt. S/A. or its equivalent
			0	1	2	3	4	6	9	
Jealott's Hill[1] .	1929	Nitro-chalk	9·5	..	15·3	..	18·9	21·9	..	62
	1930		11·2	..	..	12·8	..	16·2	18·1	20
	1931		12·8	..	..	17·6	..	22·6	24·8	40
Woburn .	1932	S/A. No Dung .	13·3	17·8	19·7	..	24·4	..	..	54[2]
		S/A. Dung .	19·2	21·2	23·7	..	28·7	..	..	
Midland College .	1931	N/Soda . .	15·3	18·2	19·1	..	22·4	..	..	53
	1932	Nitro-chalk .	22·8	24·4	26·6	..	..	..	..	49

Thus kale shows a marked response to nitrogen ; even the largest applications have given profitable increases in yields. Diagrammatically, the yield curves show no signs of reaching a top limit ; so that still heavier applications are now being tested. Kale appears to make better use of large quantities of nitrogen than any other roots. Even if the increase in total crop were no greater than with other roots, the starch equivalent and protein equivalent increases would be greater on account of its analysis, especially the increase of protein equivalent, a point of real importance.

Different types of nitrogenous fertilizers vary in their efficiency when applied to root crops. Nitrate of soda, for instance, is more effective than sulphate of ammonia for mangolds. The most efficient fertilizer for kale is still unknown, but price consideration weights the balance in favour of sulphate of ammonia.

Kale shows a marked response to dung and probably appreciates a combination of dung and artificials more than do swedes. Yet at Woburn in 1932, a season with well-distributed but moderate rainfall, the effect of the dung (15 tons per acre) could have been produced, at much less cost, by using slightly over 1½ cwt. sulphate of ammonia: but this of course is the result of only one particular season and ignores the residual value of dung for the following crops. Nevertheless, in a system of mechanised farming where dung is scarce, kale might prove a suitable root-crop on this account as well as from labour considerations.

Some Cultivation Points.—Kale possesses a big advantage over root crops in its powerful smothering effect, which exceeds even that of potatoes. Another important point is that the yield does not greatly depend on the plants' space for lateral development as is so necessary for the bulbs of swedes. These two points reduce considerably the labour requirements of the crop.

(1) *Number of Plants per Acre.*—The first question to consider is how wide apart should the rows be, and how thick the plants in the row, to give the highest yield of starch equivalent and protein equivalent. Unlike swedes and mangolds, the leaves of kale are

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[1] Fertilizers and Food Production.—Keeble, p. 188.

[2] There was no significant difference in response to S/A. whether dung was applied or withheld.

as important as the stems; but they have quite a different composition. The figures for the 1932 Rothamsted thinning experiment are given below, combining the figures for both treatments, but other kale crops may of course give analyses appreciably higher or lower. The unthinned stems contained less nitrogen than the thinned.

	Dry Matter	Per cent. N. in Dry Matter	Per cent. Fibre in Dry Matter
Leaves . . .	12·7	2·89	10·4
Stems . . .	14·0	1·53	22·2

The effect of spacing on the proportion of leaf to stem is thus of great importance. Data on this point are only now being collected, so that they do little more than form a basis for one or two preliminary suggestions.

The effects of thinning and not thinning were tested at the Midland College in 1932. With plants 12 inches apart in the drill, the yield was 24 tons per acre, with plants 4 inches apart 25·2 tons—a suggestive but not significant difference, supported, however, by the results of an unpublished experiment done elsewhere. At Rothamsted this question was also studied in 1932, the leaf-stem ratio being determined and the leaves and stems analyzed separately. The results are as follows, the depression of yield through thinning (to 18 inches in 24-inch rows) being significant:—

	Approx. No. of Plants per acre	Total Yield Tons per acre	Per cent.		Per cent. D.M. (L+S)	Per cent. in D.M.		Yields in cwt. per acre		
			Leaf	Stem		N.	Fibre	D.M.	N.	Fibre
Unthinned .	55,000	26·6	30	70	14·0	1·78	18·7	74·5	1·33	13·9
Thinned .	14,500	24·4	37	63	13·1	2·17	17·0	64·2	1·39	10·9

The forester plants trees close so as to obtain timber instead of branches and leaves. Similarly, to have a large number of kale plants per acre leads to stems predominating with their lower nitrogen content and their higher fibre. In this case the reduction of total crop due to thinning is 8·3 per cent., but of dry matter it is no less than 13·8 per cent. and of fibre 22 per cent., while there has been a slight increase in nitrogen. The unthinned crop, despite its higher fibre, has clearly the greater value.

A fairly high density of plants appears then to be desirable, and a consideration of the relative value of leaves and stems leads to the suggestion, not yet tested, that the more equally spaced the plants on the ground the greater the value of the crop; a rather thin plant in 18-inch drills may be better than a thicker plant in wider rows. Allowance must be made for pests, however, and there are risks of obtaining no plant when aiming at a thin one; it may thus be sounder in practice to keep to 24-inch drills, especially if yields are to be forced up to the 40-ton level. It is not clear that there should ever be need to have them still wider.

A seed-rate of 3 lb. per acre should be ample, and, if the tilth is really favourable, this can safely be reduced. Too thick a plant can always be successfully thinned by harrowing without need for resorting to hand labour.

Questions are sometimes asked about growing kale as a broadcast crop. This cannot be recommended for it will generally prove disastrous. Only when land is perfectly clean and highly fertile, with abundant nitrogen, is there any chance of success.

(2) *Cultivation Operations.*—In the main, cultivation operations are the same for kale as for other root crops, but economies are possible in two directions. Thinning being unnecessary, the crop may well be sown on the flat unless the field is very dirty, and the number of horse-hoeings, or tractor-cultivations, may be reduced. Kale grows quickly and meets in the drill sooner than swedes, so that, particularly if sown in narrower drills, its smothering effect comes quickly into action. Those who believe that the more inter-drill cultivation one gives to roots the better may question this idea. But there is no evidence that any cultivation additional to that necessary for weed control is beneficial. In fact there is evidence, though very scanty, being for 1932 only, to the contrary. Extra cultivations, on a reasonable and quite practicable scale, actually reduced the yield of kale at Rothamsted, significantly, from 26·4, obtained with just sufficient cultivations for weed control, to 24·6 tons per acre. A similar result has been obtained with other root crops.

(3) *Time of Sowing.*—Kale, like other cabbages, has a long growing season, much longer than mangolds and probably also longer than swedes; it takes up fertilizers steadily over a long period. Thus, within reason, the earlier it is sown the better, although it grows with remarkable rapidity under favourable conditions. If sown in early April, not only does it get a good start while there is usually abundance of soil moisture, but it is more likely to escape the turnip flea-beetle. This is a most serious pest, particularly in the south of England. Kale sown this year at Rothamsted on 26th April narrowly escaped destruction; sown later, it was so seriously destroyed that a further sowing was necessary. Kale may or may not be more susceptible to attacks than swedes or turnips, but at least it is no less susceptible. No treatment has yet proved really satisfactory; it is much better to defeat the enemy by being too early for him.

Utilisation of the Kale Crop.—Waste occurs both by the time and the method of utilising the crop. Least waste occurs in carting the crop off for feeding indoors during the early winter; most occurs in folding it off with sheep in late spring.

(1) *Time of Utilisation.*—An experiment was carried out at Rothamsted last winter to study the first factor. Five monthly

cuts were weighed and analysed from the middle of November to the middle of March. The figures, given on p. 28 of the 1932 *Rothamsted Report*, show that up to the middle of January, with a 25-ton crop sown on 6th May, total yields and yields of dry matter, nitrogen and fibre did not alter appreciably. The reduction in these figures for mid-February was only slight, but the last cutting showed an appreciable reduction in total yield, total dry matter and total nitrogen.

The percentage of leaf on the plants (unthinned) was—

Nov.	Dec.	Jan.	Feb.	Mar.
31·2	29·4	32·2[1]	25·4	23·0

The lower figures after January reduced still further the yield of nitrogen already affected by the fall in total yield.

The spring loss of gross yield was largely due to loss of leaves. But the total dry matter in the stems in February and March also declined, due perhaps to the translocation of food to the leaves, the percentage dry matter content of which increased during February and March.

There were several very sharp spells of frost during these five months. For twelve nights running, just before the second cut, there was an average of 4·5° F. ground frost, with several occasions with 8° and 9°. Throughout January there was scarcely a night without ground frost, and seven nights when the temperature fell below 20° F. From 15th to 29th January the kale remained frozen continuously. There was another cold spell towards the end of February, with another week when the kale remained frozen. Yet despite conditions comparable to those on the eastern arable land of Scotland, the plants looked bright green and healthy when not frozen. It was an early spring and they would have burst into flower early in April, but generally flowering is later than this.

This one experiment seemed to indicate the advisability of using the kale crop by the end of January. But it should be possible to breed heavy yielding kales that suffer less loss of leaf in spring and come later into flower.

Kale stems are generally believed to become more woody, and the whole plant less palatable, as the season advances. The failure to detect, by chemical means, any increase in the fibre content in either stems or leaves in the first four cuts is therefore interesting. There are slight indications of a rise in March.

(2) *Method of Utilisation.*—Sheep inevitably cause wasteful utilisation. On entering a new break they pull off leaves and tramp them into the mud half-eaten. Although these leaves have manurial value, this reduces the feeding value of the crop, and also its cash value as previously estimated. Then, too, the stems are left to the last and, in some cases, never completely cleared up. It seems

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[1] This rise was due to more moisture on the leaves.

unwise, for the sake of the sheeps' progress, to force them to do much clearing up of stems in an old break before giving them a fresh one. If, instead, they are allowed a wide run back, it is surprising how well even fattening hoggs will clean up. Observation has failed to show that managed in this way, with plenty time to clean up behind them, there is any greater waste in February than in December. Where desired, ewes can be brought on as followers to the hoggs ; but in-lamb ewes can be folded on the fresh crop itself for a short time daily without harmful results.

Another possibility, where soil conditions and fencing allow, is to run store cattle over the folded ground to finish clearing it.

The other method of utilising the crop is to cart it off. This is probably the most irksome task connected with the kale crop, as plants, especially if they are unthinned and numerous, are very awkward to handle. But the cutting of the crop is an operation that could fairly easily be mechanised, just as maize cutting has been. We have found it an advantage to use corn carts for carting, and even where favourable conditions allow of heavy loads to have a man on the cart loading the plants. Carting kale is more expensive than carting swedes. It should not of course be carted when frozen, but this is sometimes very difficult to arrange.

Some method of storing marrowstem kale will evidently be necessary to enable it to compete successfully with a well-grown crop of swedes or mangolds in March and April. No satisfactory method is yet known, but silage may prove the solution. Small plants of kale, but not big ones, give a quite attractive clamp of silage when treated by the A.I.V. process. While this would increase the labour costs of handling the crop, the work would be done at a relatively slack period and the increase might not thus be very material. A big advantage would be set against it ; if the root break were cleared by the end of January, ploughing for the next crop could proceed, and there would be much more chance of sowing this on a good tilth and early enough to obtain a full yield.

However the kale crop be utilised, big roots, with stems at least 2 or 3 inches high, are bound to be left behind. Even the best ploughing, particularly if done shallow for barley, cannot bury them all, and in some cases partly buried roots are to be seen lying all over the field. It is pretty hopeless to try to use ordinary harrows, but disc-harrows work admirably, and can often later be followed with chain-harrows. It should be unnecessary to spend labour removing heaps of roots, unless perhaps a few collected by the chain-harrows, and there should be no difficulties in sowing the following corn with an ordinary disc-drill. There are many advantages, however, in following kale with potatoes instead, with a rotation something like this : potatoes, wheat, barley, temporary ley $\begin{cases}\text{oats, kale :}\\ \text{kale :}\end{cases}$ with dung applied to kale and/or potatoes.

Other Points about Kale.—Three further advantages over other root crops are claimed for kale. It is said to resist finger-and-toe better than swedes and turnips; it imparts no turnipy flavour to milk; and it is claimed to give better yields, under conditions of drought, than the regular root crops. It appears that these claims are possibly justified, although experimental confirmation is required.

Unfortunately kale has one very serious drawback, sufficient in itself to deter many farmers from growing the crop. Pigeons, as well as hares, rabbits and other vermin, are very fond of it; pheasants, too, in the winter will pick the stems hollow. Trouble begins after the plant reaches the four-leaf stage. Luckily it has remarkable powers of recovery, and a crop with nothing but the leaf mid-ribs left, if unthinned, can fill up to give a full yield. Trouble recommences in the winter, particularly in frosty weather, when crowds of pigeons flock into the crop and soon greatly reduce its value.

The damage is less serious if one has a fairly extensive acreage and if several neighbouring farmers are also growing the crop. But before kale becomes an established crop in Scotland, it may prove necessary to deal with the pigeon menace.

Summary.—Kale is an attractive crop because of several favourable points. While it has a higher feeding value, weight for weight, than any root crop and is a particularly efficient converter of nitrogenous fertilizers into protein, yet it is economical in its labour requirements. Taking into account the operations saved and allowing for any extra expenses like heavier carting costs, it should be grown for at least 20s. an acre less than other roots. Marrowstem kale can replace other roots till the end of January without appreciable loss, and it has shown a surprising resistance to frost, at least in the south of England.

There are many blanks in our knowledge of the kales as well as the other root crops, and their present importance, arising out of our changing agriculture, justifies concentrating attention on the production of improved types and on the best methods of handling and utilising the crop, as recommended recently in one of the agricultural reports of the Scottish National Development Council.

Kale also possesses some disadvantages; it suffers badly from bird and vermin damage; it loses weight and value in the spring and comes into flower early; there is liable to be waste when the crop is consumed on the ground; the remains of the stems may cause trouble in preparing for the next crop.

The most likely way of ensuring a good crop is to sow early under favourable conditions and to supply abundance of nitrogen.

PEAT MOSSES—IV

CULTIVATION AND CROPPING OF PEAT LAND

IAN M. ROBERTSON, B.Sc., Ph.D.

The Macaulay Institute for Soil Research

Cultivation.—The object of land cultivation, whether it be in a mineral or a peat soil, is to produce in the soil the most suitable physical condition for the growth of crops and for the micro-organisms taking part in the soil-forming processes. This condition is usually associated with a fine, crumbly texture where the soil particles are uniformly small and loosely held together, and is known as the soil " tilth." A good tilth naturally implies an adequate supply of air and water in the soil, and ease of penetration for the plant roots. A bad tilth, on the other hand, is associated with a lumpy or sticky soil texture, insufficient aeration, an inadequate or in some cases an excessive water supply, and a resistance to the growth and spread of plant roots in the soil.

In their natural conditions the peat mosses of Scotland do not readily lend themselves to the production of a good tilth. Generally, the vegetation is composed of heather (*Calluna*), cotton grass (*Eriophorum*), deer's hair grass (*Scirpus*) and molinia (*Molinia*), all of which possess exceedingly tough and resistant roots. These plants form peats which do not easily decompose, and are difficult to break down into the small particles necessary to form a good soil. In some cases, too, the presence of the roots of shrubs and trees, such as birch, rowan and fir increases the difficulties attending the cultivation of peat land, especially in areas which have been drained, and where conditions more favourable for the rapid growth of heather and shrubs have been introduced. Before attempting to break up such a land surface, it is advisable to burn off the tough surface vegetation. A good time for this is in early spring, when a dry spell often occurs before the sap rises in the plants. Where the vegetation is particularly tough, or where a thick mat of roots is encountered, it is often useful to break the surface into fairly large clods and expose these to winter frosts before the burning is commenced. In this way it is possible to remove at a small cost a very troublesome surface layer of vegetation and roots, and provide a surface much more suitable for cultivation.

The production of a good tilth on a freshly reclaimed peat soil, however, is no easy matter, and it may not be obtained until the land has been worked for several years. The addition of lime, which is necessary to counteract the natural acidity of the peat, should be made as early as possible, in order to increase the numbers and activity of the cellulose-splitting bacteria, and bring about decomposition of the upper layers of the peat. The action of lime on a well-drained peat-soil is very quickly seen, and after a few years the whole character of the surface layers is altered. The colour of the peat changes from a yellow or light brown to dark brown or black, and the soil particles, which at first are wet, coherent lumps of tough material, break down to a fine, friable compost resembling a well-decomposed turf or leaf mould. These changes extend only to the depth of cultivation and the peat immediately below this level remains practically unaltered. The depth of cultivation is, therefore, a most important factor, and whenever possible the land should be worked to a depth of about 8 inches. Care should, of course, be taken that lime and manures are uniformly mixed throughout the layer of cultivation to enable plant roots to penetrate it freely. It may be pointed out that in a peat soil the plant roots occur only where the natural acidity of the peat has been neutralised by the addition of lime, and where a sufficiency of plant nutrients exists, so that it is absolutely necessary to work in lime and manures to the maximum depth of cultivation, in order to make full use of the cultivated layer as a medium for plant growth. Failure to observe this point is often attended by harmful results, since plants whose roots are confined to a shallow surface layer often suffer from lack of water, an occurrence rarely seen where lime and manures have been worked in to a depth of about 8 inches.

It may be mentioned here that peat land is best utilised as hay and grass land. The production of a good sole of grass, however, is almost impossible, unless a very fine seed bed suitable for the very small grass seeds is available, and in the first year or two of the cultivation of newly-reclaimed land, the preparation of such a surface usually presents great difficulties. To begin with, the broken peat clods form a lumpy, uneven seed bed, and it is therefore customary on the Continent to crop the land for two or three years before laying it down in grass. The natural soil-forming processes have then time to come into play and are assisted by the mechanical working associated with crop production, and also by the root action of the crop. In the first, or first and second years, before the neutralising action of the lime is fully effective, a relatively acid condition prevails, and the most suitable crop is oats. As the final crop before laying down in grass, potatoes are usually chosen, and when farmyard manure is available as well as artificial, a really good growth can be obtained. The weeds so prevalent in peat soils are thus reduced to a minimum, and the working of the soil assisted by the vigorous root action, produces an excellent seed bed which is merely harrowed over and sown down in grass in the succeeding spring.

To turn now to the actual working of newly-reclaimed peat land, two distinct procedures have to be considered :

(1) Cultivation with specially designed implements.

(2) Cultivation with ordinary farm implements.

There is no doubt that the modern mechanically-driven implements, specially designed for work on peat land, provide the quickest and most successful means of cultivation. This is especially the case in the first few years, when the ground is too soft and wet to be worked by horses. By attaching broad wheels to the implements, the danger of sinking in the soft peat is minimised, and in exceptional cases where the surface is particularly soft or uneven, a caterpillar tractor can be used.

Where the land is to be ploughed, it is first necessary to cut up the surface layer with harrows, and for this purpose several very efficient implements can be obtained. The most successful is a rotary knife harrow (Hankmo Harrow),[1] consisting of a stout framework on which are supported three rows of four-bladed knives arranged alternately and slightly bent. As the implement is drawn along, the knives revolve and cut the peat into small pieces. The framework may be weighted to increase the depth of cultivation. Even on a very tough surface this implement does excellent work. Other suitable harrows are the large disc pattern, or better, the cut-away disc type, but any sharp cutting implement will prove successful.

Whichever implement is used, the ground should be well worked in one direction and then crossed, so that as complete a subdivision as possible is obtained. The land can now be ploughed with a suitable tractor plough. If ploughing is carried out without previously cutting up the surface with harrows, continuous furrows of tough peat are merely turned upside down, and are extremely difficult to break up to form a good tilth. In addition, the hard surface when inverted, forms a very poor connection with the water-supplying subsoil and in a dry year insufficiency of water may result.

While the procedure outlined above is very successful, it is somewhat slower and less efficient than cultivation carried out with large moor cultivators, particularly where large unbroken stretches of peat land are to be worked. These cultivators (one of which is in use in Lewis and has already been described in this Journal) [2] are attached immediately behind a suitable tractor fitted with very broad wheels. Cultivation is carried out by means of bent steel knives fixed to a rapidly revolving horizontal drum. With such a machine it is possible to cultivate to the maximum depth required, and even after a single working a really excellent subdivision of the peat is obtained. In the case of very tough fibrous peat the cultivation may be undertaken in two operations. In the first, the machine is set so as to work the top three or four inches, and in the second the area is crossed and cultivated to the maximum depth. Lime and manures may also be worked in by means of the cultivator ; this ensures an almost perfect distribution throughout the soil. The great advantage of using a moor cultivator lies in the fact that the working of the land and mixing of manures is so completely carried out that the area can be sown down in grass without any previous cropping.

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[1] *Scot. Jour. Agric.*, 1932, xv., 176.

[2] *Ibid.*, 1930, xiii., 125.

After the peat has been reduced to a fine state of subdivision, it is usually much too soft and " fluffy " to form a good soil. Rain-water runs through it very quickly and carries off the plant nutrients. In dry weather the soil soon loses its moisture, and having little capillary connection with the subsoil, has no means of making good the water which is lost by evaporation and transpiration. The use of a heavy roller overcomes these difficulties; by firming up the soil and strengthening the capillaries which conduct the water from the lower levels to the surface, this helps to maintain favourable moisture conditions in the cultivated layer. Rolling is particularly beneficial in the case of hay and pasture, since these require more water during the growing season than most other crops.[1]

Where tractors are available, large water-filled rollers are often employed, and on the Continent it has been found that when possible a weight of about 6 to 6¼ cwt. per foot of working surface should be aimed at. The approximate dimensions of such an implement are : 4 feet diameter by 5 feet 9 inches in length, the weight being 1¼ tons empty and 3¼ tons when full of water. One advantage of a water-filled roller over a cement or sand-filled one is that its larger diameter makes it less liable to sink in soft ground, but should bogging occur, the water can easily be run out leaving only the light shell to be removed from the peat. In addition, the weight of the water-filled roller can be varied at will according to the nature of the ground to be rolled.

The cultivation of newly reclaimed peat land by means of ordinary farm implements is much slower than with special machinery, but the final results are just as satisfactory. Horse-drawn harrows and ploughs are of necessity lighter than those designed for tractor work, so that the cutting of the surface and also the ploughing have to be repeated a number of times to obtain the required degree of subdivision in the peat. With this method of cultivation, cropping of the land for some years and exposure of the ploughed surface to winter frosts is necessary before laying down to grass. To begin with, when the land is very soft, horses find great difficulty in walking, and to prevent their sinking, moor shoes consisting of a flat square of wood attached to the under side of the hoof by detachable metal bands should be employed. Such shoes ease considerably the labour of walking on the soft peat, and as the ground becomes firmer the front pair, and finally both front and back pairs, can be dispensed with. The large water-filled rollers are unsuitable for horse work, and a smaller cement-filled type, 3½ to 4 feet long by about 2½ feet in diameter, should be used instead.

Cropping.—The crops (apart from hay and grass) most suitable for peat soils are oats, rye and potatoes. Turnips and beet can also be grown, and if inoculation with nodule bacteria is carried out, legumes such as beans, peas, etc., form useful crops. Barley and wheat are never very successful on such land. On a freshly-reclaimed soil oats grow best, but after the first year or two potatoes should be grown to keep down weeds. Whichever crop is contemplated, great care should be taken in choosing the time of sowing or planting to avoid late frosts. The peculiar nature of peat soils renders them particularly susceptible to the action of late frosts, and crops sown too early suffer accordingly. Rolling with a light roller, however, has been found to minimise the risk of frosting in grain crops. Potato varieties which grow quickly and have large haulms should be selected, since once the ground is well covered it is more or less protected from the cooling action of frost.

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[1] *Scot. Jour. Agric.*, 1933, xvi., 161.

A further point to which attention should be given is the choice of seed, and numerous investigations have demonstrated that better results are obtained with seed which has been grown on peat land than with that grown on mineral soil.

Owing to the difficulty of obtaining a fine subdivision of the peat in the first year or two, it is usually found necessary to sow grain crops by hand. Later, however (or in cases where a moor cultivator has been used), a drilling machine will be found more convenient. The planting and working of potatoes often gives trouble, and where the soil is lumpy and undecomposed, drilling is most difficult to carry out. Should this be the case, it is advisable to plant the seed with a spade or dibble on top of the drills, rather than to attempt splitting the drills in the usual manner, but where a reasonably good tilth has been obtained, the latter method is quite satisfactory. It would appear that in peat soils, drilling-up of potatoes seldom gives an increased yield and this is probably due to the loosening of the soil which allows of greater evaporation and changes in soil temperature.

Hay and Grassland.—It will be seen that cropping of peat land as described above, is attended by considerable risk from frost, and in some years grain and potato crops may suffer considerable damage. Grassland, on the other hand, although not wholly immune to such a risk, is much less susceptible to frost action and very seldom shows any deterioration due to climatic factors. From this point of view, therefore, it is most profitable to utilise peat land as hay and grassland. In addition, it has long been recognised[1] that peat land is naturally suited to development as pasture which, when properly worked, is very much superior to that on mineral soils.

Several points in regard to the sowing out of peat land with a grass-clover mixture deserve special mention. In the first place, it has been proved from numerous experiments that the sowing of a cover or nurse crop is not advisable and should be omitted.

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[1] *Scot. Jour. Agric.*, 1933, xvi., 57.

Peat soils, and in particular those which have been in cultivation for some time, are usually overrun with annual weeds such as knotgrass, groundsel, chickweed and hempnettle, and the presence of a nurse crop encourages their seeding. Generally, it will be found that the weeds shoot up before the grass and when no nurse crop is present, it is possible to go over the field with a mower and remove them more or less completely at one operation. Sometimes the low-growing weeds such as chickweed are left uncut, and dressings of ground kainit at the rate of 1½ cwt. per acre, applied on a dewy morning when the crop is damp, will prove most effective as a weed-killer.

On the Continent, ground to be sown out with grasses and clovers is first rolled as well as possible with a heavy roller and a smooth surface obtained. Shortly before sowing, a light harrow is drawn over the area and immediately after sowing the heavy roller is again applied. This procedure has proved most satisfactory.

The further maintenance of a good sole of grass depends on the correct regulation of the water level,[1] the application of suitable fertilizers,[2] and the use of a heavy roller in spring time. The first two of these points have already been dealt with in other articles, whilst the beneficial effects of rolling peat soils has been stressed above.

Notes from Agricultural Colleges

Craibstone

Grasses and Clovers, 1933.—The hay crop in the North of Scotland was generally poorer than it has been for some years, with a lack of red clover, especially on the lighter classes of soil. The weather for haymaking, however, was perfect, so that there was no loss and the weight per acre obtained was therefore heavier than the appearance of the crop indicated.

The reasons for the poor crop are : (1) the comparatively low rainfall after the grass seeds were sown in 1932 ; (2) the thick grain crop ; (3) the low rainfall during May and June of this year which hindered the development of red clover ; and (4) the kind of red clover sown.

The adverse effect of the grain crop on grass grown under different conditions was well demonstrated in a trial where different varieties of oats were sown at different thicknesses, and where part was cut early and part cut late. In the field where this trial was carried out, 20 lb. per acre of perennial rye-grass were sown in order to plough down as a green manure. The soil was light and liable to suffer in dry weather.

After the grain crop was removed and the rye-grass had started to grow, the differences were very marked. In order to show the results plainly, the plants on a representative square foot of each, were dug up, washed and weighed. The weights obtained were as follows :—

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[1] *Scot. Jour. Agric.*, 1933, xvi., 160.

[2] *Ibid.*, 327

	Wt. of plants per sq. foot grammes
1. *Effect of Variety—*	
(a) *Straw* v. *Grain Variety.*	
Pure Line Potato	9·0
Yielder	65·5
(b) *Early* v. *Late Variety.*	
Yielder	65·5
Elder	26·5
2. *Effect of Thickness of Seeding.*	
Yielder—2½ cwt. per acre	13·5
,, 1½ ,, ,, ,,	65·5
3. *Effect of Time of Cutting.*	
Yielder—cut early	193·0
,, ,, late	65·5

Owing to the dry nature of the field and the dry season, these results are possibly more marked than they would be in normal seasons, when there is an average rainfall, but they serve to indicate the precautions that should be taken in order to ensure a good sole when sowing out.

The trial shows that the most favourable conditions, so far as the nurse crop is concerned, are to sow an early variety of the grain type, not too thickly, and to cut the crop as early as possible.

It has been very noticeable during the last number of years that red clovers of different varieties and from different sources behave differently in different seasons. In some seasons both broad-leaved and late-flowering have done well; in other seasons sometimes the first and sometimes the second has been better. English broad-leaved has invariably been better than foreign. Late-flowering varieties from different sources have also varied. One year Eastern Counties English was best; another year Swedish and Montgomery were best and very similar. American Mammoth, Polish and Russian late-flowering have never done well under our conditions. This year all the broad-leaved were distinctly poorer than late-flowering, and of these Montgomery and Cornish Marl, which are of the same type, were outstandingly better than all the others. The general lack of red clover in the hay this year may, in some cases, be due to the absence of these varieties from the seed mixture.

As is usually the case when there is a lack of red clover in the hay, there was abundance in the aftermath—largely broad-leaved.

The effect of the previous manurial treatment on the hay crop was well seen in a field where no manures were applied directly to the hay crop. The seed mixture sown was one which has given good results for hay and pasture in trials in recent years on our medium soil.

13	lb.	Perennial Rye-grass (9 lb. Ayrshire, 4 lb. Evergreen late-flowering).
8	,,	Cocksfoot (4 lb. Danish, 4 lb. New Zealand).
4	,,	Timothy (Scots).
2	,,	Broad-leaved Red Clover (English).
1½	,,	Late-flowering Red Clover (English, Montgomery and Swedish).
1	,,	Alsike Clover.
½	,,	Wild White Clover (Kent).

In one trial, 1 cwt. sulphate of ammonia was applied to part of the oat crop, another part getting none, the same amount of phosphate and potash being applied all over.

	Grain cwt.	Straw cwt.	Succeeding Hay crop cwt.
1. 1 cwt. Sulphate of Ammonia to oat crop	24·9	37·2	28·6
2. No nitrogen	20·5	27·8	37·4

The sulphate of ammonia applied to the oat crop increased the amount of grain by 4·4 cwt. and of straw by 9·4 cwt. per acre, but the hay crop was reduced by 8·6 cwt. per acre, this decrease being mainly in red clover.

In second year's grass where a similar result for the hay crop was got the previous year, the white clover became established earlier in the part where sulphate of ammonia had been used to the oat crop, due to the smaller amount of red clover in the hay.

In another trial where phosphates were applied to part of the oat crop (1 cwt. sulphate of ammonia and 1 cwt. muriate of potash being included in both cases), the following result was obtained:—

	Grain cwt.	Straw cwt.	Succeeding Hay Crop cwt.
1. 4 cwt. Phosphates to oat crop .	28·0	40·2	34·1
2. No Phosphates	26·5	38·0	27·6

There was only a slight increase of grain and straw, but the hay crop was increased by about 6½ cwt. per acre, again mainly due to more red clover.

In the second year's grass of the previous crop there was no noticeable difference between the two parts, the competition of the red clover and grasses on white clover and the omission of phosphates apparently balancing each other.

An interesting result was got on both hay and aftermath from the application of different quantities of muriate of potash, first of all to the root crop and again to the oat crop, none being applied directly to the hay crop. All the plots got dressings of 1 cwt.

sulphate of ammonia and 4 cwt. phosphates to the roots and also to the oat crop. The trial may be summarized as follows :

Muriate of Potash applied		Per Acre	
(a) to Roots	(b) to Oats	Weight of Hay cwt.	Weight of Aftermath (green) cwt.
1. 1 cwt.	1 cwt.	34·1	96·8
2. None		30·7	77·0
3. 2 cwt.		36·6	112·2
4. ½ ,,		32·3	87·5
5. 1 ,,	None.	26·3	82·5
6. None		20·1	44·5
7. 2 cwt.		28·1	96·8
8. ½ ,,		22·8	65·0

Although the application of potash usually shows some effect on our soil, it is not often that such great differences are shown. This may be accounted for partly by the dry weather conditions and also partly by the fact that, in previous rotations, potash was apparently little used. It has been observed that although the application of potash may not show much increase in yield, yet when it is omitted the following crops are often deficient. It is usually well to keep up the supply.

In the trial, each additional application of potash increased the amount of red clover, both in hay and aftermath, plot 3 being outstanding. Also the applications to the oats had more effect than those to the roots. It was very noticeable that the grasses in No. 6 plot were much less vigorous than in the other plots, and were apparently suffering from the lack of nitrogen which the red clover was providing in the other cases.

In last year's note attention was drawn to a trial where a plot of new grass had been grazed by sheep in November and another plot in May, and then set aside for hay. The field was again made into hay this year, and the opportunity was taken to estimate both the weight of hay and the ingredients present, with the following results :—

	Per Acre					
	Perennial Rye-grass cwt.	Cocksfoot cwt.	Timothy cwt.	White Clover cwt.	Weeds cwt.	Total cwt.
1. Grazed, Nov. 1931	19·3	8·8	6·2	1·4	0·8	36·5
2. Grazed, May 1932	12·8	9·3	2·9	3·6	3·5	32·1
3. Ungrazed	17·7	9·0	7·9	1·9	1·2	37·7

The late grazing in May 1932 increased the amount of dwarf plants—white clover and weeds—while it reduced the amount of perennial rye-grass and especially timothy. The quantity of white clover present in No 2 plot was greater than the figures indicate, as, being dwarf, a considerable proportion of it was left uncut. When examined before the aftermath was grazed at the beginning of August, this plot contained the most wild white clover, but the grasses were not so prominent.

Daisies appeared to be more plentiful in many pastures this spring than they often are, probably due to the weather conditions not being so favourable to the growth of grasses. Several observations were made regarding them. First of all, daisies are a legacy from previous rotations, and there is no doubt that many of the seeds, although small (there are about 4,000,000 in 1 lb.), are able to remain fresh in the soil during the three years of an ordinary six-course rotation that the field is under crop. Where daisies are prevalent, it would be well to sow grasses and clovers rather thicker than usual in order to try to prevent their entrance in the pasture. A good example of this point was seen lately where one side of a broadcast sowing machine was set closer than the other, so that instead of a uniform seeding of 30 lb. per acre there were alternate strips sown at the rates of about 25 and 35 lb. per acre respectively. There were about three times as many daisies in the thin as in the thick part. Similarly, there were more daisies in plots where comparatively small quantities of perennial rye-grass were sown, and also more where Danish cocksfoot was sown than where New Zealand was sown.

Daisies, like other dwarf plants, are encouraged when the hay crop is cut early, as was well seen in a field where part was cut early and another part cut late. They are further encouraged when second year's grass is eaten bare at the beginning of the season. In a trial where nitrogenous manure was applied in March to part of a field of second year's grass, both grasses and white clover were encouraged, with the result that the amount of daisies was greatly reduced.

In one case wild white clover was very slow in getting established in second year's grass this year. This was partly due to the very dry conditions in spring and especially in summer, and partly to the hay crop of 1932, which was heavy and contained a large proportion of red clover. Where there was comparatively little red clover, and also in one part where the hay had been cut early, the white clover came in much earlier in the season and was much thicker. These parts were first eaten by the cattle. In part of one field which had been grazed the previous year, the white clover came earlier and is now much thicker than in another part that had been hayed. In this part, however, cocksfoot and timothy are not so prominent. An interesting feature in this field was that the pastured part contained a considerable number of thistles, whereas in the hayed part there were comparatively few.

The trials with different types (stalky and leafy) of grasses, especially perennial rye-grass and cocksfoot, indicate that both should be included in seed mixtures. The former type, especially Danish cocksfoot, comes earlier in the spring and is thus very valuable in providing early grazing. This year, also, it is interesting that, as is usual, it did not come into ear at all but was well kept down, whereas the ears of New Zealand cocksfoot were very prominent during midsummer, although they were all subsequently eaten down. Another feature was that the New Zealand cocksfoot had a considerably adverse influence on white clover. On the other hand, white clover was much more prominent in the part where Danish cocksfoot was sown, with the result that all the grasses were much fresher and greener, due to the nitrogen provided by the white clover. In a grazing trial there was practically no difference in the live weight increases obtained per acre from mixtures containing Ayrshire perennial rye-grass and Danish cocksfoot on the one hand and Evergreen perennial rye-grass and New Zealand cocksfoot on the other. Other grazing trials showed: (1) that there was little difference in the live weight increases obtained between (*a*) the rotational and (*b*) the continuous methods of grazing; and (2) that 3 cwt. sulphate of ammonia applied to a field of five-year-old grass with abundance of wild white clover did not make the grazing earlier nor increase the amount of milk produced as compared with a part that got no nitrogen.

A large number of samples of white clover was again sown, and these again showed that great care must be taken when selecting this seed. While there is no difficulty in getting good genuine samples, there are many inferior samples on the market. Seed of the former is usually smaller in size and rounder in shape than the latter, and gives a strong chemical reaction. Even the best of New Zealand samples, although they give a very strong chemical reaction, in many cases stronger than English, have not done so well nor lasted so long in the field as good English samples. Ordinary white, even although up to 4 lb. per acre were sown, was practically a failure. It is a loss to include it in seed mixtures.

Auchincruive

Investigations on Seed Mixtures for Hay and Pasture.—In 1931, part of the sow-out area was used to provide facilities for grazing observations on different grass seed mixtures in which evergreen perennial rye-grass, leafy cocksfoot, crested dogstail, and liberal proportions of fescues were contrasted with a control mixture. These were sown out under oats, and in 1932 were cut for hay, while this year, 1933, the area has been rather heavily grazed since the beginning of May.

The actual mixtures used are given in the following table :—

NAME OF PLANT	A Lb. per acre	B Lb. per acre	C Lb. per acre	D Lb. per acre	E Lb. per acre
Perennial Rye-grass . .	12	—	12	12	12
Evergreen Perennial . .	—	12	—	—	—
Italian Ryegrass . . .	4	4	4	4	4

Name of Plant	A Lb. per acre	B Lb. per acre	C Lb. per acre	D Lb. per acre	E Lb. per acre
Cocksfoot (Danish) ,, New Zealand	8	8	—	8	—
,, Stapledon	—	—	8	—	—
Timothy, Scotch ,, Canadian	5	5	5	5	5
Meadow Fescue	—	—	—	—	7
Tall Fescue	—	—	—	—	7
Rough-Stalked Meadow Grass	2	2	2	—	2
Crested Dogstail	—	—	—	2	—
Broad-Leaved Red Clover	1¼	1¼	1¼	1¼	1¼
Late Flowering Red Clover	1¼	1¼	1¼	1¼	1¼
Alsike Clover	1½	1½	1½	1½	1½
Wild White New Zealand	1	1	1	1	1

It should be noted that A represents the control, and that the composition of the others (B, C, D, and E) is similar, except for one ingredient, viz:—

Mixture B.—Evergreen perennial rye-grass replaces ordinary commercial rye-grass.

Mixture C.—A leafy type of cocksfoot from the Welsh Plant Breeding Station replaces the Danish and New Zealand.

Mixture D.—Crested dogstail replaces rough-stalked meadow grass.

Mixture E.—Meadow and tall fescue replace cocksfoot.

As regards grazing, it may be said that all of the seedings provided good pasture. It was evident, however, that in mixture D (in which crested dogstail was included) the sole was rather thin. Doubtless this defect will be remedied as the years go on, as this grass has decided powers of spreading and establishing itself in a pasture. Towards the end of summer, the familiar woody flowering stems became conspicuous, and this in spite of the fact that the whole field had been fairly closely grazed. It would thus appear that close grazing alone is not always effective in preventing this undesirable condition, and that the mower should be more freely used in the month of June.

Of the others, mixture E was particularly satisfactory. The plot was closely and evenly grazed and was entirely free from the coarseness sometimes associated with mature cocksfoot or crested dogstail.

Scarcely less good was the mixture in which the leafy strain of cocksfoot provided by the Welsh Plant Breeding Station was used.. Although attractive in appearance and readily eaten, the actual bulk of forage produced appeared to be less.

There seemed to be very little to choose between mixtures A and B. Compared with the control, mixture B containing evergreen perennial rye-grass was slightly earlier in providing keep in spring and equally good in appearance. The total amount of growth was rather less, however, and this was even more noticeable in the previous year when the plots were cut for hay.

In 1932, an experiment covering a greater number of seed mixtures was laid down. In this case, such problems as leafy strains of grasses, heavy seedings of particular grasses, complex mixtures and bottom grasses only were intended to be investigated. Twenty-four plots were laid off—twelve seed mixtures sown under a cover crop of oats, and a duplicate set of twelve without a cover crop of any kind. These latter were numbered 13 to 24. Details of the mixtures are as follows, and the outstanding feature of each is indicated at the top of the related column :—

NAME OF PLANT	1 13	2 14	3 15	4 16	5 17	6 18	7 19	8 20	9 21	10 22	11 23	12 24
	Italian	Evergreen Perennial and Italian	Evergreen Perennial and Cocksfoot	Commercial Perennial and Cocksfoot	Evergreen Perennial and Commercial Cocksfoot	Commercial Perennial and Evergreen Cocksfoot	Heavy Seeding Cocksfoot	Heavy Seeding Timothy	Complex Mixture	Only Bottom Grasses and Wild White Clover	Heavy Seeding Meadow Fescue	Heavy Seeding Meadow and Tall Fescue
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Perennial Rye-grass ..	—	—	—	14	—	14	—	—	—	—	—	—
Evergreen Rye-grass ..	—	9	14	—	14	—	9	9	9	—	—	—
Italian Ryegrass	12	5	—	—	—	—	—	—	3	—	—	—
Cocksfoot (Danish) ..	—	—	—	7½	7½	—	6½	—	—	—	—	—
,, (New Zealand)	7½	7½	7½	—	—	7½	7	3	3	—	3	3
Timothy, Scotch	4	4	4	4	4	4	2	4	2	—	2	2
,, American ..	—	—	—	—	—	—	—	5	—	—	—	—
Hard Fescue	—	—	—	—	—	—	—	—	—	8	—	—
Meadow Fescue	—	—	—	—	—	—	—	—	5½	—	22	11
Tall Fescue	—	—	—	—	—	—	—	—	5	—	—	10
Meadow Foxtail	—	—	—	—	—	—	—	—	3	—	3	3
Rough Stalked	1	1	1	1	1	1	1	1	1	4	1	1
Crested Dogstail	—	—	—	—	—	—	—	—	—	4	..	—
Broad Leaved Red ..	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	—	1¼	1¼
Late Flowering	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	—	1¼	1¼
Alsike Clover	1½	1½	1½	1½	1½	1½	1½	1½	1½	—	1½	1½
Wild White Kentish ..	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	¾	¾
,, ,, New Zealand	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	¾	¾

Evergreen perennial rye-grass is used in every case, with the exception of Plots 4 and 6, where ordinary commercial rye-grass is used.

New Zealand cocksfoot is used in every case, with the exception of Plots 4 and 5, where Danish cocksfoot is used.

In Plot 7, half of the cocksfoot is New Zealand and the other half Danish.

This year a fence was run through the middle of the plots to allow of half of each being grazed and half being cut for hay.

As regards grazing, an outstanding observation was the marked preference of the cattle for Plots 1 and 13, in which Italian rye-grass was the predominant plant. In spite of the fact that the grass was rather long at the commencement of grazing, the stock at once concentrated on these plots and quickly reduced them to an even carpet-like sward. There can be little doubt, from this and previous observations, of the peculiarly high palatability of Italian rye-grass.

In general the other plots were not so efficiently grazed, but, comparatively speaking, no very marked individual differences could be detected during this season.

In the case of Plot 10 (bottom grasses only) the amount of wild white clover was clearly greater, but there were more weeds and it seems probable that this seed mixture will be unable to withstand the initial competitive period and that an inferior pasture will be developed.

In the case of the halves of the plots cut for hay, it was possible to obtain a quantitative measure of the results. The plots were cut on June 22nd and made into hay in the usual way. The produce was weighed at the time of leading and a representative sample of each taken for dry matter analysis. The yields of hay and of dry matter per acre are given in the following table :

Plot No.	Yield of Hay Per Acre Cwt.	Yield of Dry Matter Per Acre Cwt.
1	60·0	47·7
2	61·8	46.9
3	68·1	54·1
4	60·7	48·2
5	60·0	48·5
6	62·1	50·4
7	61·0	48·5
8	66·4	52·6
9	61·0	50·6
10	48·6	39·6
11	62·5	49·3
12	65·7	53·1

It will be seen that the yield from Plot 10, *i.e.* from the mixture of bottom grasses and wild white clover, was lowest, and indeed this plot was quite unsatisfactory for hay. At the same time it is interesting to note that the soft thick nature of the crop presented an exceedingly difficult problem to the mower.

The other yields are too similar to allow of accurate deductions from one cutting, but it is hoped to obtain further series of figures.

The yields from the duplicate set of plots (sown without a covering crop), were parallel to the above, but averaged between 5 and 6 cwt. per acre more than the first series. This is easily explained by the fact that a crop less had been removed from the soil, and while it is not suggested that the extra yield of hay would compensate for the loss of the oats, it emphasises the fact that, where a course of cropping is undesirable or impracticable, worn out pasture can be very efficiently renewed by a direct sow-out.

As regards aftermath, the plots in which Italian rye-grass formed part of the mixture made distinctly the quickest and greatest recovery.

Historical Notes on the Leaf Roll of Potatoes

THESE notes are contributed by Mr Robert L. Scarlett, C.D.A.

The prevalence of leaf roll in potatoes this year has caused very deep concern to everyone interested in growing a healthy potato crop, and it may not be out of place to consider the findings of past generations on the trouble.

The *Memoirs of the Royal Caledonian Horticultural Society*, published in 1814, discuss the outstanding topics of the times, among which the curl in the potato and the making of currant wines occupy the chief place.

These references to potato curl have been quoted from time to time with perhaps little interest being shown, but a fairly diligent search revealed the fact that other records of national importance dealing with the leaf roll were published about that time, and some extracts from these may interest students of the trouble to-day.

In the *Memoirs* referred to, the subject is given as: "Observations on the Disease in the Potato, generally called the Curl; pointing out the most probable method of preventing it; with an account of the results of a few experiments made on the subject," by Mr Thomas Dickson, Leith Walk, Edinburgh. Read, 6th March 1810.

So valuable was this paper considered at the time that Mr Dickson was honoured with the first gold medal given by the Society, and afterwards became Secretary.

He begins: "This disease first began to be alarming to the growers of the potato about thirty-five or forty years ago. Since that time it has continued to engage the attention of many eminent agriculturalists and gardeners."

He goes on to describe the various theories held regarding its origin and cause, and credits the Hon. Baron Hepburn of Smeaton in East Lothian, "one of the most successful and intelligent agriculturalists in this country, as the originator of the theory that curl was probably caused by using over-ripe tubers for seed."

Evidently this caused a great deal of controversy, and Mr Dickson goes on to point out that potatoes being propagated vegetatively are certain to lose their vitality, and gives the results of experiments he carried out in 1801-2-3, which resulted in his advocating the use of unripe seed as a preventative for curl.

The potatoes with which he experimented were a Long Kidney, from which he cut sets from the wet or unripened ends, which produce plants continuing healthy and producing abundant crops, while those sets taken from the dry ends, or as we should say, the heel ends, continued to degenerate.

He, therefore, advocates procuring seed potatoes from high country; to lift these whenever the haulm becomes of a yellow-green colour; and to prevent them producing flowers.

About the same time a Mr John Shirreff, writing on the curl disorder in potatoes states, that in order to obtain vigorous plants and secure productive crops, recurrence must frequently be had to varieties newly raised from seed.

A further communication, read 13th September 1814, by Mr John Young, Belmont Castle, describes his experiments which go to suggest that potatoes for seed ought not to be stored where they have too much light or air, as he maintains that these conditions weaken the tubers and render the future plant weak and curled.

He further states that "these sorts that contain the greatest quantity of farinaceous matter as the Leather Coat and Red Nose Kidney, are worst with the curl, which is one strong proof that over-ripe tubers produce it."

By the kindness of the Department of Agriculture, a volume entitled *Communications to the Board of Agriculture on Subjects Relative to the Husbandry and Internal Improvement of the Country*, vol. ii., Second Edition, 1805, was obtained from the London Library and placed at the disposal of the writer, and on page 325, Communication XV. was found: "Observations on the Causes and Prevention of Curl in Potatoes," by a Farmer (Midlothian).

His first paragraph runs as follows :—

"Hitherto the curl has been considered as a specific disease arising solely from contagion, without which, it is supposed, that it cannot be produced, and that this contagion necessarily propagates the disease in all crops with which it is allowed to come in contact."

He goes on to state that in many instances to his knowledge the curl has appeared in crops, the seed of which came from districts where curl was unknown, and that even healthy potatoes could be obtained from curled potato plants, "nothing being more frequent than abundance of curled potatoes from roots chosen with the greatest care." Many well-known potato raisers have thought similarly!

He says whatever renders a crop poor and weakly is most apt to produce it, and enumerates the causes in various paragraphs :—

1. Planting potatoes on ground altogether unfit for them.

"When cultivated first, potatoes were planted on the lightest land on the farm and all the work done by spade, but as production extended, care in cultivation diminished."

He gives an instance of a field wherein half an acre was clay and the rest a dark coloured sandy loam, in which potatoes grew free from curl on the loam, while a great proportion were curled on the clay.

2. Imperfect culture and preparation of the soil.

"The effect of complete previous tillage for the culture of potatoes is indeed so remarkable that there is reason to believe that the amount of our potato crop in a great proportion of cases would be more than double what it commonly is, if the ground on which they are planted was previously put in better order."

He gives as an example : A crop of 300 Winchester Bushels per Scotch acre = 8-10 tons, and close by double the crop under the Lazybed System.

3. Choose healthy full-grown seed, and do not use small potatoes.

"Plants raised from seed being commonly for the first, second or third years very weak and feeble," he does not recommend raising many from seed, which is in direct opposition to the other authorities, although he rather upsets some of his contentions when he mentions one experiment in which some were planted from all curled plants, the produce from which all went down ultimately with curl.

4. Sets from roots which have sprouted early and rubbed off, never fail to produce curl. The second sprouts are too weak.
5. Too much or too little dung.
6. Too deep as well as too shallow planting.

The first was evidently most frequently pursued in those days. He recommends 3 inches deep and quotes an experiment in depth planting, in which those planted from 1 to 2 inches deep appeared first, were very weak and some curled ; those planted 3, 4, and 5 inches deep were all strong, healthy and entirely free from curl ; those planted 6 to 7 inches deep do well, but are three weeks later in appearing ; those planted 8 inches deep are very weak and very late, with nine plants out of twelve curled; those planted 12 to 18 inches deep never appeared at all, but on digging up appeared the same as when planted.

7. Injuries produce curl, *e.g.*, from horses' feet, harrows, etc.
8. A field rolled after planting, makes it too solid and produces curl.
9. *Weather.*—A long continuance of dry weather when the shoots first come forth, particularly when accompanied with severe cold winds, is very bad to produce curl. Frost seldom fails to produce it, particularly hoar frost.

He says "every farmer may observe that nothing tends with more certainty to prevent curl and produce perfect roots than frequent showers in the early stage of the crop," and considers the planting time of extreme importance, giving the first three weeks of April as best for the South of Scotland and North of England.

"The general result of all these observations is that the curl is not a disease, but only an accidental debility to those plants in which it occurs. The farmer is not to seek a cure in a change of seed alone, but in complete attention to all that experience shows to be necessary for an accurate culture of the crop against its dreadful enemy, the curl."

He quotes the general opinion as being, " the curl depended on infection while other causes had been overlooked."

He disputes the reason of growing potatoes frequently on the same ground, by saying that in those districts where curl was first perceived to an alarming extent, it has disappeared altogether for a season or two and is equally frequent on new ground to potatoes.

It is rather strange but still very much up-to-date for him to state that *formerly better potatoes were grown.*

" We are not to suppose that the curl even by the best management is ever to be entirely prevented." His last paragraph reiterates all the arguments previously used, and finishes :

" With a view to encourage a full production of roots, this will in almost every instance prevent any important loss from curl and would, therefore, universally ensure abundant crops of dry wholesome roots, instead of these scanty productions of bad, and there is reason to fear, unwholesome potatoes, which to the disgrace of many of our farmers, are in various districts frequently met with."

A still earlier volume seen in the National Library of Scotland is entitled, *A Report of the Committee of the Board of Agriculture concerning the Culture and Use of Potatoes*, 1795. A revised edition of this was published in 1808.

The Napoleonic Wars having upset the whole of Europe, there was undoubtedly cause for great alterations in cropping systems. Early in spring 1795, the Board of Agriculture took into consideration the dearness of provisions and among other ideas none seemed to merit so immediate an attention, as to encourage a more extensive cultivation of potatoes.

The Report extends to some hundred odd pages, and includes communications from all parts of the country, and it is evident that the findings are based upon the opinions of growers situated all over Great Britain.

These communications are mainly boiled down to a very few words. A special chapter is devoted to *distempers of the potato*, the curl being the chief. The curl is avoided by changing seed. The varieties mostly quoted are Red Nose in England, Red Neb, Surinam, and Blackamoors in Scotland.

In the chapter on curl in the North Riding of Yorkshire, where seed is procured from moorlands or from Scotland, the curl is avoided the first year ; in the second year some are curled ; in the third year all.

In an experiment where lime and ash dung was used, curl was produced, while Lancashire farmers sent their favourite kinds to mossy land to recover.

The author of the West Lothian Survey said : " It is somewhat singular that this distemper is unknown in the higher districts of the county at an altitude of 400 feet above the level of the sea."

He goes on to ascribe " the cause of this freedom, to the frost setting in early in the season in this elevated situation and destroying the haulm of the potato before it is completely ripe."

He is severely criticized for this opinion, as it is argued " that the more completely the bulbs or seeds of young plants are matured, the more perfect and productive will they be for seed."

The other authorities quoted said " the curl was asserted to be owing to forcing the plants from which the sets are taken, by manure or earthing up."

" A southern aspect and rich land is bad for curl."

" No curl was found in the mountains of Radnor and Montgomery. It was caused by sowing the same sorts on the same land."

" Potatoes procured from moss or peaty land will not curl. The curl is due to earthing up and from choosing the largest roots from seed that were made large by earthing and hosing. Fresh dung very detrimental."

In Yorkshire, the moorlands at that time were practically free from it, while the vale land was invaded.

Another said, " It is a question whether the curl is not owing to potatoes being kept during winter in the house, as when kept in pits underground, few of them are liable to that distemper. '

Immediately after the potato boom at the beginning of the twentieth century, Mr W. P. Wright, lecturing before the Royal Horticultural Society on 24th October 1905, refers to curl:

" Almost seven years ago, the dread scourge ' curl ' made its reappearance." A series of wet seasons brought about the " boom " in potatoes, thought to be resistant to blight (*Phytophthora*), but "cultivators declared it was the series of hot, dry summers (which followed the boom period), prematurely ripening the crops which caused the trouble." He stresses the point about immature seed.

"Although the too familiar *Phytophthora* has not left us, the ' curl ' and ' black scab ' has come. This has worked terrible havoc in recent years."

"The remedy is only to be found in change of seed from higher districts where it is less mature."

These notes and remedies proposed and tested by our forefathers are surely helpful to study, as showing how they faced and attempted to solve difficulties similar to ours.

Leaf curl is so widespread this season that every possible care must be taken by potato growers to secure and plant only from clean stocks to maintain the standard of Scottish seed potatoes.

Growers may feel annoyed when some of their fine fields have been " turned down," owing to the prevalence of curl and mosaic, yet the Department are to be congratulated upon their strenuous endeavours to maintain the standard, which is the only thing that matters, in view of the very great importance to Scotland of a healthy potato crop.

Poultry-keeping on a Northern Farm

A NORTH of Scotland farmer, impressed with the need of developing this side of the activities of one of his farms, started poultry-keeping on what for the district was an extensive scale, some six years ago. The principles aimed at were :

(1) The start to be made in a moderately small way—development later.

(2) The keeping of only healthy birds of a good strain.

(3) As low overhead and labour costs as would be consistent with good results.

(4) The building up of a trade for settings of eggs and day-old chicks.

A previous attempt had ended in disaster because of bacillary white diarrhoea. Precautions were therefore taken to buy hatching eggs from blood-tested stock. Sufficient chickens were hatched to provide 600 laying pullets the first year. These were accommodated in two 300-bird houses costing £100 each, with food stores at one end. The sites of these houses were permanent, but provision had been made to have them within easy access of a constant supply of drinking-water. Economy in labour was thus provided for. The following year the stock was doubled by the addition of 600 more pullets, the one-year-old hens being kept on for another year. At first the results were disappointing. Experience had to be gained in the matter of economic handling of foods, when to hatch to get winter egg production to the fullest possible extent, etc. Bit by bit the worst difficulties were overcome ; the poultry side of the farm became more profitable than all the rest of the farm put together ; the stock was gradually increased ; the buying-in of slatted-floor houses capable of holding 120 birds reduced housing charges to 2s. per bird, instead of 6s. 8d. in the case of the 300-unit house. It was found that a man and a woman could cope with 1900 laying hens, manage incubators holding 2900 eggs, rear more than the requisite number of pullets required to replace the stock, bring the cockerels to the killing stage and deal with all the marketing that could be done without leaving the premises. It is necessary to explain here that a large trade in hatching eggs and day-old chicks was built up, and although large orders only were catered for, the amount of work involved in dealing with the correspondence and in despatching orders was distinctly large. In spite of this the labour charge per adult bird was no higher than 1s. 11d. in 1931-32 and 1s. 8d. in 1932-33.

Financial Results.—The financial results vary from year to year largely in accordance with several factors including the sales of hatching eggs and day-old chickens. For the year 1932-33 the results were very much poorer than in the previous year, in which a record profit was obtained. Nevertheless it probably gives a truer picture of the finances of the farm at present-day prices. In calculating results an arbitrary division between ordinary farm expenses and the poultry account had to be made. On the expenditure side items are expressed in pounds only.

Balance Sheet—1932-33

(1900 adult bird unit)

Income—		
Sales of eggs, stock, etc.	£1441 12 0	
Valuation increase—poultry	49 13 0	
Do. do. equipment	20 0 0	
Do. do. food in hand	16 0 0	£1527 5 0
Expenditure—		
Food	£650 0 0	
Wages	158 0 0	
Repairs and additions to equipment	115 0 0	
Rent of grass land, etc.	30 0 0	
Oil, carriage, advertising, telephone, etc.	64 0 0	
Replacements (stock), testing, etc.	74 0 0	1091 0 0
Profit		£436 5 0

Approximate profit = £436.

Discussion of Results.—Comparing the above results with those obtained by costing officers in the North-east of Scotland for farms where the main end in view is profitable poultry keeping, one is struck by the similarity which prevails. This is indicated by the following comparative table:

Expenditure

Farm Above—Year 1932-33 1900 adult birds (approx.)		*Costing Farms previous to* 1932 (Embracing nine poultry years, average size of flock, 292 adult birds)	
Cost of food	6s. 8d.	Cost of food	6s. 2d.
Labour	1s. 8d.	Labour	2s. 11d.
Overheads	2s. 2d.	Overheads	3s. 4d.
Cost of maintenance	10s. 6d.	Cost of maintenance	12s. 5d.

INCOME

Average receipts per bird, eggs and stock	15s. 2d.	Average receipts per bird, eggs and stock	17s. 9d.
Profit per adult bird	4s. 8d.	Profit per adult bird	5s. 4d.

Other Results.—Harris, working on the same lines in the North of England, found an average profit per layer of 6s. 2d. (*The Farm Economist*, vol. i., No. 1, for year ending September 1931).

Senior, on the same lines, working in Scotland, obtained an average profit of 7s. 2d. (*Scottish Journal of Agriculture*, vol. xv., No. 4).

Lessons to be Learned.—In reviewing the results on the above farm, certain points call for remarks. Attention had been paid to the main consideration in successful poultry keeping. Good and healthy stock had been purchased, the capital and overhead costs for labour, etc., per bird had been kept as low as was consistent with good management, while a specialised market had been created. Further, every effort had been made to obtain a plentiful supply of winter eggs and to have a large percentage of cockerels marketed while the markets were good. To ensure these two ends a brooder house was erected. The experience gained with this house indicated that chickens can be reared quite easily all through the winter. Hatching has been done earlier and earlier every year. This past year the incubators were started in November.

As regards housing, the 300-unit house has been found to have certain disadvantages. The structure being permanent, land round about the house easily becomes fouled, particularly during the winter season. The average yields per bird are thought to be distinctly lower than where houses accommodating a large quantity are employed. The capital cost per bird for this type of house compares unfavourably, too, with the slatted-floor type. So far, this latter type has given very good results, but until this system is tested by a prolonged and severe winter it would be unwise to draw complete deductions.

The inadvisability of stressing egg production before everything else was indicated one year when the abnormal high average of 192 eggs per bird per annum for a 300-unit house of White Leghorn pullets was accompanied by a fairly heavy death-rate, due to no well-defined disease. The problems of the future in connection with this farm, so far as production is concerned, appear to lie along the lines of finding out the best type of house that will make for low capital cost per bird, easy working, good laying results and freedom from disease. On the marketing side the problem to be solved is how to reach the consumers in a less costly fashion than rules at present.

Official Statistics

THE annual *Guide to Current Official Statistics* provides a very necessary key to the storehouse of statistical information contained in the hundreds of surveys, periodicals, returns and reports on a wide range of subjects which are published each year by Government Departments. It gives not only a list of the titles and prices of official publications containing statistics, but also an extensive alphabetical index showing the nature and scope of the information available on each subject.

Volume XI. of the *Guide* (price 1s. net, post free 1s. 5d., 344 pp.) has just been issued, and may be obtained direct from the sale offices of H.M. Stationery Office or through any bookseller.

Agricultural Returns for Scotland, 1933

THE Preliminary Statement of the Agricultural Returns taken in Scotland as at 4th June 1933 shows that the total area under crops and grass amounts to 4,603,000 acres, comprising 3,018,000 acres of arable land and 1,585,000 acres under permanent grass. The total acreage is the smallest recorded since 1876, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1932 by 28,000 acres. The area under permanent grass has increased this year by 9000 acres, making the actual diminution in the area under crops and grass 19,000 acres.

The area under rotation grasses and clover, 1,468,000 acres, has decreased by 43,500 acres, while the " tillage " area, *i.e.* that under grain, green crops, etc., is 14,750 acres larger than in 1932.

There have been reductions in the areas of barley, oats and vetches, tares, etc., for fodder amounting to 22,400 acres. Increases in the areas of wheat and potatoes amount to 30,500 acres, and of mixed grain, rye, beans, peas, turnips and swedes, mangolds, sugar beet, rape, small fruit and other crops to 6650 acres.

The outstanding features of the crop returns are the large increase in the area under wheat, the further increase in potatoes, and the decreases in barley and oats. Wheat, with an increase of 26,000 acres, or 50 per cent. over 1932, reaches an area of 78,000 acres, which is the highest acreage recorded since 1882, with the exception of the war years 1918 and 1919, when the areas under the crop were 79,000 acres and 79,500 acres respectively. Barley has decreased by 7900 acres to a new low record of 61,000 acres, and oats have decreased by 13,400 acres to 854,000 acres. The area under potatoes, 153,000 acres, is the largest recorded since 1922, when it was 157,400 acres. Sugar beet has increased from 650 to 1800 acres, while the acreage under small fruit shows an increase of 350 acres, almost entirely accounted for by raspberries. There are increases in the acreage under carrots of 65 acres and slight increases in the other crops not separately specified in the accompanying table.

Of the area under permanent grass, 177,000 acres were cut for hay and 1,408,000 acres were grazed, while of the area under rotation grasses and clover, 392,000 acres were cut for hay and 1,076,000 acres were grazed. The area under permanent grass for mowing was greater than in 1932 by 10,500 acres, and that under rotation grass for mowing was less than in 1932 by 5000 acres ; the total area cut for hay is thus increased by 5500 acres.

The live-stock returns show that horses and sheep have decreased in numbers, while cattle, pigs and poultry have increased.

Horses used for agricultural purposes are fewer than in 1932 by 1400, the total, 114,300, being the smallest on record. Unbroken horses of one year and above are fewer by 100, or 0·7 per cent., while foals show an increase of 300, or 6·1 per cent., on last year's figures. The decrease in horses of all kinds is 1000, or 0·7 per cent.

The total number of cattle, 1,278,900, is greater than last year's figure by 45,600, or 3·7 per cent. With the exception of bulls, which are down by 200, all classes of cattle show increases.

The total number of sheep, 7,745,200, shows a decrease of 171,200 or 2·2 per cent., as compared with that of 1932. Ewes, which number 3,360,000, are 82,600 less than last year's record number, a decrease of 2·4 per cent., while lambs have decreased by 54,700, or 1·6 per cent. Rams show a decrease of 900, while other sheep, one year and above, show a decrease of 33,000, or 3·4 per cent.

Pigs, which total 166,000, show an increase of 700, or 0·4 per cent., on last year's figure. Sows have increased by 2200, or 11·1 per cent., and boars have increased by 400, or 18·2 per cent. Other pigs have decreased by 1900, or 1·3 per cent.

The returns of labour employed (excluding occupiers of holdings, their wives and domestic servants) at 4th June 1933 are given below, together with the figures for 1932. Regular workers are fewer by 900, while casual workers show an increase of 1500.

The returns of poultry at 4th June 1933 are also given below, together with the figures for 1932.

	1933	1932
Regular Workers—		
(*a*) Males, 21 years old and over	58,700	58,900
(*b*) Males under 21 years old	19,400	19,900
(*c*) Women and Girls	17,900	18,100
Casual Workers—		
(*a*) Males, 21 years old and over	6,600	5,400
(*b*) Males under 21 years old	3,500	2,700
(*c*) Women and Girls	5,800	6,300
Totals	111,900	111,300

	1933	1932
Fowls over six months old . .	3,700,000	3,486,100
Fowls under six months old . .	4,250,000	3,952,000
Ducks over ,, ,, ,, . .	161,000	161,800
Ducks under ,, ,, ,, . .	95,000	82,200
Geese over ,, ,, ,, . .	7,300	6,900
Geese under ,, ,, ,, . .	19,000	16,200
Turkeys over ,, ,, ,, . .	17,700	14,200
Turkeys under six months old .	103,000	72,000
Totals .	8,353,000	7,791,400

There is given below a Preliminary Statement, compiled from the returns of varieties of potatoes grown in 1933, of the acreage as at 4th June under the principal varieties, together with the figures for 1932. The acreage accounted for here is 131,000 acres, the remaining 22,000 acres not being included in the returns of varieties. The finally revised figures will be published as usual in October.

	First Earlies			Second Earlies	
	1933	1932		1933	1932
Duke of York .	1,700	1,500	Ally . .	400	400
Eclipse . .	2,200	1,500	Great Scot .	8,800	9,000
Epicure . .	9,400	8,700	British Queen .	3,800	3,800
Sharpe's Express	2,500	1,900	Royal Kidney .	700	500
Others . .	1,200	1,100	Others . .	1,300	1,400
Totals	17,000	14,700	Totals	15,000	15,100

	Maincrops	
	1933	1932
Arran Banner .	1,600	1,200
Arran Consul .	1,100	900
Golden Wonder .	8,500	9,400
Kerr's Pink . .	55,000	62,100
Majestic . .	10,800	8,500
Arran Chief . .	1,800	2,200
King Edward VII.	13,700	12,300
Others . .	6,500	5,300
Totals	99,000	101,900

CROPS AND GRASS

DISTRIBUTION	1933	1932	INCREASE		DECREASE	
	Acres	*Acres*	*Acres*	*Per Cent.*	*Acres*	*Per Cent.*
TOTAL AREA (excluding WATER)	**19,069,007**	19,069,007	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (a)	**4,603,000**	4,622,000	..	..	19,000	0·4
ARABLE LAND	**3,018,000**	3,046,000	..	..	28,000	0·9
PERMANENT GRASS (a) For Hay	**177,000**	166,500	10,500	6·3	..	..
PERMANENT GRASS (a) Not for Hay.. ..	**1,408,000**	1,409,500	..	..	1,500	0·1
TOTAL ..	**1,585,000**	1,576,000	9,000	0·6	..	..
Wheat	**78,000**	52,000	26,000	50·0	..	..
Barley (including Bere)	**61,000**	68,900	..	..	7,900	11·5
Oats	**854,000**	867,400	..	..	13,400	1·5
Mixed Grain	**2,000**	1,600	400	25·0	..	..
Rye	**3,000**	2,600	400	15·4	..	..
Beans (to be harvested as Corn)	**3,000**	2,700	300	11·1	..	..
Peas	**700**	500	200	40·0	..	..
Potatoes	**153,000**	148,500	4,500	3·0	..	..
Turnips and Swedes	**350,000**	348,500	1,500	0·4	..	..
Mangolds	**1,700**	1,000	700	70·0	..	..
Sugar Beet	**1,800**	650	1,150	176·9	..	..
Cabbage	**4,800**	4,800	..	..	..	..
Rape	**8,800**	7,750	1,050	13·5	..	..
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	**8,000**	9,100	..	..	1,100	12·1
Small Fruit	**8,250**	7,900	350	4·4	..	..
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER For Hay ..	**392,000**	397,000	..	..	5,000	1·3
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER Not for Hay	**1,076,000**	1,114,500	..	..	38,500	3·5
TOTAL ..	**1,468,000**	1,511,500	..	..	43,500	2·9
OTHER CROPS	**4,700**	4,100	600	14·6	..	..
BARE FALLOW	**7,250**	6,500	750	11·5	..	..

LIVE STOCK

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural Purposes (including Mares for Breeding)	**114,300**	115,700	..	..	1,400	1·2
Unbroken Horses (including Stallions) One year and above	**14,500**	14,600	..	..	100	0·7
Unbroken Horses (including Stallions) Under one year ..	**5,200**	4,900	300	6·1	..	..
TOTAL ..	**134,000**	135,200	..	..	1,200	0·9
Other Horses	**15,100**	14,900	200	1·3	..	..
TOTAL OF HORSES ..	**149,100**	155,100	..	..	1,000	0·7
Cows in Milk	**360,000**	351,300	8,700	2·5	..	..
Cows in Calf, but not in Milk	**53,600**	53,500	100	0·2	..	..
Heifers in Calf	**64,500**	60,700	3,800	6·3	..	..
Bulls being used for Service	**17,800**	18,000	..	..	200	1·1
Other Cattle :—Two years and above	**200,000**	190,100	9,900	5·2	..	..
,, ,, One year and under two ..	**313,000**	300,200	12,800	4·3	..	..
,, ,, Under one year	**270,000**	259,500	10,500	4·0	..	..
TOTAL OF CATTLE ..	**1,278,900**	1,233,300	45,600	3·7	..	..
Ewes kept for Breeding	**3,360,000**	3,442,600	..	..	82,600	2·4
Rams to be used for Service	**95,200**	96,100	..	..	900	0·9
Other Sheep :—One year and above	**930,000**	963,000	..	..	33,000	3·4
,, ,, Under one year	**3,360,000**	3,414,700	..	..	54,700	1·6
TOTAL OF SHEEP	**7,745,200**	7,916,400	..	..	171,200	2·2
Sows kept for Breeding	**22,000**	19,800	2,200	11·1	..	..
Boars being used for Service	**2,600**	2,200	400	18·2	..	..
Other Pigs	**141,400**	143,300	..	..	1,900	1·3
TOTAL OF PIGS	**166,000**	165,300	700	0·4	..	..

(a) Excluding Mountain and Heath Land used for grazing.
(b) The figures for 1933 are subject to revision.

Agricultural Conditions

Remarkably fine and dry weather was experienced throughout the whole country during June. Occasional local showers of rain occurred in the last two weeks but, taken on the whole, the crops did not receive sufficient moisture for satisfactory growth. The absence of rain was accompanied by a temperature well above the normal for the season. During the following month the temperature was somewhat higher, and in Scotland generally it was the warmest July for thirty years. The first two weeks were dry but during the third week the drought was relieved by local showers, which recurred at fairly frequent intervals until the end of the month. Most of the hay harvest was completed in excellent order before the weather became unsettled, but intermittent thunderstorms during the last week caused a small part of the grain crops to be lodged. In the eastern counties dry conditions prevailed throughout most of August, several days being delightfully bright and sunny. In these districts the grain harvest proceeded speedily and was finished at an exceptionally early date. In the south-west the first two weeks were mild and mainly fine, but the latter part of the month was cloudy and, at times, severe rainstorms were widespread. In this area harvest was often delayed for short intervals by wet weather and on some farms harvesters were barely able to keep pace with the ripening of the grain crops. In western districts and more particularly in the north-west, wet and broken weather was general for most of the month, with the result that a considerable proportion of the uncut grain was lodged. In the western islands the weather was more or less unsettled throughout July and August, and in Skye at the beginning of September much of the hay crop had not yet been stacked, while some of it had been damaged by the weather.

On the heavier and better class of land wheat progressed exceptionally well during June, but on light soil the plants suffered from a lack of rain. The dry, warm conditions favoured the rapid development of the plants and towards the end of June the crop was in ear. During July the ears filled well and ripened quickly, and in eastern districts cutting was general during the first week of August. Very little of the crop was lodged and as it was cut with comparatively little labour, it was secured in very good condition. Harvest was practically completed and most of the grain was in stack before the beginning of September. The straw is slightly shorter than usual, but in practically all districts where the crop is grown, the yield was estimated at from 5 to 10 per cent. above the average ; in Kincardine and some parts of Perth and Ayr, however, it was thought that the crop would give no more than an average yield, while in south-east Perth the produce was estimated at 5 per cent. below the normal.

Where barley was sown late the crop was adversely affected by the dry weather, and it soon became apparent that the best results would be obtained on early-sown fields. The drought had a steadying effect upon growth and the straw was rather shorter than usual, but the ears were well-filled and at the end of July the crop was almost ready for harvest. Where the plants were well headed parts of the crop were somewhat lodged and twisted, but it suffered no serious damage and harvest proceeded fairly quickly; in most of the eastern counties cutting did not become general until the first week of August and in the west until the second week. At the beginning of September it was thought that the straw would probably prove to be below the average in bulk, but in most districts the yield of grain was expected to be fully up to the average and in several cases the estimates were 5 per cent. above the normal. In Moray, Banff, Sutherland, Orkney, West Aberdeen, North-East Angus and South Ayr, however, the yield of barley and bere was estimated at 5 per cent. below the average of the last ten years.

Where they followed lea, oats generally grew well and in some fields very well, but where sown after turnips, the plants were not at all vigorous and soon lost colour as a consequence of the dry weather. The straw was short, particularly on heavy land and where the crop was sown late. Moreover, in several districts the process of ripening was irregular—on sandy soil at the end of July much of the grain was completely ripe, while on other parts of the same fields at that time some of the crop was still green. The grain generally ripened about three weeks earlier than usual and some of it had become too ripe before it was secured, but harvest was generally carried out under favourable conditions and the quality and colour of the sample were good. In the west a proportion of the crop was badly lodged during the last few days of August. No complaints were received of damage done by insect pests or disease. The estimates of the probable yield were not so good as in the case of wheat or barley. In sixteen districts it was thought that the yield would equal the average, while in four districts an excess of 10 per cent. was anticipated and in six others an excess of about 5 per cent. In fourteen areas, however, the yield was estimated at 5 per cent., in South Ayr 10 per cent. and in Central Perth 15 per cent. below the normal.

Beans showed quick, steady growth and the plants were in flower at the end of June. The rain that fell during the second half of July greatly benefited the plants and, although the stems were rather short, the crop podded well. At the beginning of September harvest was in all stages of completion, but in several districts most of the crop had been secured. In Stirling it was thought that the yield would exceed the average by about 15 per cent., in North-East Fife by 10 per cent. and in the Lothians and South-West Perth by about 5 per cent. An average crop was expected in Berwick, South-West Fife, Clackmannan and South-East Perth.

In the southern counties at the end of June early varieties of potatoes were yielding an average crop of tubers of good quality. At this time the bright weather conditions favoured the growth of late varieties, the shaws of which were reported to be well forward for the date, but rain was required to swell the tubers, especially on light or sandy soil. During July the haulms, which had a strong appearance and good colour, showed practically no signs of disease but, as a consequence of the continued dry weather in most of the more important potato-growing areas the prospects became less and less promising and, at the end of August in several eastern districts it was anticipated that the yield would show a deficiency varying from 5 to 15 per cent., as compared with the average of the last ten years. The crop ripened rapidly and in some cases prematurely, and the tubers, though plentiful, were small. The best results were expected in the west and north, where the haulms generally had a strong appearance and, at the beginning of September, the tubers were growing well.

Where turnips and swedes were sown early, the plants at first did well and at the end of June singling was almost completed. Later-sown turnips did not grow as well as usual and in some fields at that time, the crop was in rather a critical condition. Re-sowing was necessary to a greater or lesser extent in many districts. The rainfall of the second half of July came in time to revive the growth of the plants to a remarkable extent, but in some fields the crop was still irregular, particularly where sown and thinned late. During August growth was checked by the drought that prevailed in practically all eastern districts ; at the end of that month the roots were not bulbing at all well and the shaws were rapidly losing colour for want of moisture. The most unfavourable reports were received from the Lothians and Berwick, where the crop was patchy in the fields and rather badly affected with mildew. The crop was fairly healthy generally but a few complaints were received that some damage had been caused by finger-and-toe. In the western half of the country, as might be expected from the heavier rainfall, the prospects at the beginning of September were much brighter. Indeed, in a few western districts the roots made excellent progress, especially during the latter part of August. Taken as a whole, the swede crop made better progress than turnips. The yield of turnips and swedes, as estimated at the end of August, was expected to be about average in fifteen districts, about 5 or 10 per cent. above average in eleven districts, practically all of which are in the west or north, and from 5 to 40 per cent. below average in seventeen districts, most of which are in the eastern counties. Mangolds grew fairly satisfactorily and suffered comparatively little from the dry conditions. The rain that fell in the south-west during the latter part of August improved the prospects of the crop and a good, bulky yield was anticipated in most districts. Sugar-beet grew better than has been the case for the last few years. The development of the plants suffered no appreciable checks and, in those districts where grown, the crop was healthy and showed promise of a good sugar content. The roots were still growing at the beginning of September.

The harvesting of hay began considerably earlier than usual and made uninterrupted progress under exceptionally good conditions during the latter part of June and the first part of July. On many farms in the eastern counties the harvest was completed in record time and, as practically all the work was carried out without a shower of rain, the quality of the hay on these farms is better than it has been for some time. In some western districts, however, hay-making was occasionally delayed by local showers and, at the beginning of August, a considerable proportion of the crop was still in the fields. Thirteen of the reports received at the beginning of August gave the probable yield of " seeds " hay as from 5 to 10 per cent. above the average, while nine estimated an average yield, but seventeen anticipated a deficiency of 5 per cent., two 10 per cent., and one, North Aberdeen, 15 per cent. The estimates for meadow hay were a little better than those for " seeds " hay.

So far as quantity was concerned, the small-fruit crop was rather disappointing. The spell of dry, bright weather hastened ripening but at the beginning of July berry fruits were in need of rain. Some of the strawberry crop ripened before the fruit had swelled properly and the yield was small. The strawberry season was early but shorter than usual. Raspberries suffered less than strawberries from the lack of rain and, although on low ground, the yield was somewhat affected by the dry conditions, in later and high-lying districts the crop was very satisfactory. In most districts of Perth and in North-East Angus the crop was about equal to the average and in North-West Lanark it was reported as " large," but in South-West Angus and South-East Lanark the pickings were rather lighter than usual. Gooseberries and currants were fairly good crops generally. In apple orchards the flourish was very satisfactory. The dry weather had comparatively little effect upon orchard fruits and at the beginning of August the prospects were generally reported to be good for apples, pears and plums. Some of the apple trees carried a very heavy crop and in most cases the condition of the fruit was excellent. At the beginning of September in Lanark and Stirling it was estimated that the yield of orchard fruits would be well above the normal; elsewhere it was thought that the yield of apples, pears and plums might perhaps exceed the average.

After the month of June grass was not at all abundant but it was generally of good feeding value. During August some pastures in the eastern counties became rather bare but the dry weather did not have so deleterious an effect upon pastures as might have been expected and few complaints were received of scarcity of grass. Grazing cattle throve well and in several districts were reported to have made exceptional progress. Dairy cows maintained their good average condition but, as a consequence of the drought, extra hand-feeding was necessary in order to keep up the milk yield. The clipping of the sheep stocks was generally carried out in fine weather and the hoggs and ewes improved quickly without the fleece. One or two reports, however, stated that lambs did not fatten so quickly as usual. Several complaints were received that flocks were badly troubled with maggots and it was stated that in North-East Aberdeen old shepherds said this had been the worst season for maggots they had known. Hill lambs came down to the markets well-grown and in good bloom and the prices realised were rather higher than at last year's sales.

Taken on the whole, the season was very favourable for stocks of bees and there was no mention of disease causing unusual trouble anywhere. The yield of flower and clover honey was exceptionally good generally and the honey was of good quality. At the beginning of September the bees were still gathering heather honey and the prospects were satisfactory.

Farm work everywhere was generally well forward for the season of the year and, as a consequence of the favourable weather conditions at harvest time in the principal arable districts, comparatively few extra workers were necessary. Farmers generally had no difficulty in securing temporary assistance and the supply of local casual workers, supplemented in the south by a few Irish labourers, was generally adequate for requirements. The supply of regular workers was rather more than sufficient for the demand.

SCIENCE AND PRACTICE

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS

Production of Disease-Free Swede Seed. *J. C. Neill. N.Z. Jour. Agric., Volume* 46, *No.* 4, *April* 1933.—Swedes are the most valuable fodder crop in New Zealand and they do well almost everywhere in that country. Within recent years the area sown with swedes has steadily declined, entirely on account of fear of diseases such as "Dry-rot" and "Club-root" or "Finger-and-toe." These diseases have become so widespread in incidence and so destructive in effect that swedes have become a risky and often unprofitable crop.

Investigations concerning these two diseases have extended over many years, and they have enabled certain conclusions to be drawn, viz.:

(1) Dry-rot infection is carried in the seed. If seed free from the disease is sown on land that has not carried a diseased crop for the past two seasons, nor is in the neighbourhood of swedes or turnips grown from infected seed, then the resulting crop will remain free from dry-rot.

(2) Club-root can be practically controlled by the use of certain varieties or strains of swede which are highly resistant to the disease, if precautions are taken in the sowing.

In view of the great importance of having adequate supplies of guaranteed dry-rot-free seed of club-root resistant strains available to the farmers of New Zealand, methods are outlined for the production of high-quality disease-free swede seed.

On Treating Seed Potatoes for the Control of Common Scab. *G. B. Sanford. Scient. Agric., Volume* 13, *No.* 6, *February* 1933.—Critical studies were made to obtain definite information on the value of a number of seed potato treatments commonly recommended for protection against scab. Methods of conducting trials are described in detail and the results obtained are summarised by the author as follows:

1. A comparison has been made of the efficiency of certain disinfectants and fungicides, which are commonly recommended for treating seed potatoes to prevent common scab caused by *A. scabies.*

2. Hot formaldehyde, cold formaldehyde, mercuric chloride or Bayer No. 649, used as soak treatments, produced no perceptible effect in reducing common scab on the resulting crop in field culture.

3. In sterilised soil of optimum moisture content *A. scabies* grew vigorously and practically in contact with cores of potatoes treated with hot formaldehyde, cold formaldehyde, mercuric chloride, or Bayer No. 649 solutions, as with those coated with sulphur, Semesan Bel or Bayer No. 649 dusts.

4. The planting of untreated scabby sets did not increase the amount of scab on the resulting crop.

5. When sets were coated with a virulent culture of *A scabies*, only a slight amount of scab appeared on the new crop and then only on a few of the tubers which grew close against the old inoculated set.

6. When sets were planted in soil culture of *A. scabies*, only that part of any tuber which grew in the inoculated soil area was covered by scab.

7. It is concluded that the methods now recommended for disinfecting seed potatoes to reduce common scab on the resulting crop are of no practical value under ordinary field conditions.

8. It is also contended that the relative efficiency of one tuber treatment over another cannot be demonstrated under ordinary field conditions.

9. The question is raised whether the amount of the scab pathogene in the soil is augmented by the planting of scabby, untreated, potato sets beyond the increase which normally occurs.

Studies on the Germination of Frost-Damaged Oats-seed (*Undersökningar över Grobarheten hos Frostskadat Havreutsäde*). *O. Tedin and A. Gärsner. Sveriges Utsädesförenings Tidskrift, Volume* 43, *No.* 1, 1933. *From the authors' English Summary.*—Eighty samples of oat-seed of different varieties and from different parts of Sweden were germinated in the laboratory, and also planted in the field. About sixty of the samples were more or less damaged by frost, the rest were free from every trace of such damage. Before the investigation the samples were grouped in two lots, so that the lowest (first) kernels of the spikelet were kept separate from the second kernels. Half of each lot was treated for half-an-hour with ⅛ per cent. Germisan ; the rest was left untreated.

Under favourable conditions the apparently (according to laboratory analysis) healthy seed in a sample, heavily damaged by frost, is equal to the seed of a completely healthy sample. Whether this will hold true even under unfavourable conditions is still an open question, and the investigation has given no definite indication as to whether it is recommendable to use frost-damaged lots for seed, balancing the low percentage of healthy seed by a proportional increase in the amount used.

It seems safe to conclude that second seeds are less damaged by frost than first seeds, and that the difference increases by increasing frost damage.

It is left beyond doubt that there is a relation, the main feature of which is that badly frost-damaged lots also show strong attack of fusarium.

Some Swedish farmers claim that, when oats are attacked by frost, hard cleaning, in order to reduce the percentage of second seed, should be avoided since by hard cleaning the germination power of the grain is decreased. This investigation has shown this view to be correct. It is true that the average difference in percentage plants between second and first seed is only about 3 per cent., which seems of small practical importance. It must be remembered, however, that this difference increases with increased damage, and further, that a marked parallel between frost and fusarium damage has been demonstrated, the latter also being heavier on first seed, the difference increasing with increasing attack, and heavy frost attack followed by heavy fusarium.

Moisture Content of Farm Products. *Nature. Volume* 132, *No.* 3332, 413.—A definite need exists for a cheap and rapid method for estimating the moisture content of various farm products in the field, to enable agriculturists to determine with a greater degree of safety when grain may be stored and hay carted. W. H. Cashmore, of the Agricultural Engineering Institute, University of Oxford, has developed a method, similar to that described earlier by Bouyoucos, based on the fact that finely divided grain rapidly gives up moisture to alcohol until a definite distribution of water between the grain and the alcohol is reached (Institute for Research in Agricultural Engineering:

University of Oxford. *A Rapid Method for Measuring the Moisture Content of Wheat,* by W. H. Cashmore, pp. 24, Oxford, 1s.). The amount of water given up to the alcohol varies with the moisture content of the grain, and can be measured by finding the increase in the specific gravity of the alcohol. The necessary apparatus is cheap and simple and an estimation can be made in half-an-hour. Definite quantities of meal and methylated spirits are mixed, stirred, and filtered after twenty-five minutes, the specific gravity and temperature of the filtrate being taken immediately. The moisture content of the meal is then read from a calibration table, corrections for various sources of error being made if necessary. The method can be adapted for hay, which is finely cut instead of ground, and for soil, the technique varying slightly according to the material under examination. It is possible that the method might also be adapted for materials of high moisture content, estimations of which are often difficult and take much time.

CO_2 in Photosynthesis. *Tschesnokov and Bazyrina,* 1932. *Proc. of Leningrad Soc. of Nat., Volume* 61, 3-4.—Photosynthesis is regarded as an important study in crop research, not only because of its predominant rôle in building up the plant, but because a close study of this process will assist in an understanding of the processes constituting growth.

The authors show that the effect on photosynthesis of increasing the concentration of CO_2 in the atmosphere is much less than is supposed. They hold that previous investigators have used too large a leaf surface, thereby reducing the concentration of CO_2; there would thus appear very little photosynthesis in atmospheric concentrations of CO_2, but on adding this constituent, a large increase would become evident. Much glass-house and other work have convinced the authors that the real increase is very small.

Glass-house work has shown that definite yield increases are, however, obtained by increasing the CO_2. Thus doubling the concentration of CO_2 raised the yield of radish and oats by 12 and 60 per cent. respectively. The increases were due, however, not to increased intensity of photosynthesis, but to a greater number of stems being produced from each seed. Thus, in the barley experiments an average of 3·9 stems grew from one seed in ordinary air, and 5·68 stems in air enriched with CO_2.

The cause of this increase in yield is not known. It may, for instance, be due to a direct stimulation due to increased CO_2, or it may be the result of stimulation caused by a small increase in photosynthesis.

SOILS

The Nitrate Concentration of the Soil Solution and the Factors Determining its Magnitude. *Rheinwald. Zeit. Pf. Dung. u. Bodenk,* 1933, 30, 1/3, 82.—A study was made of the effects of temperature and rainfall on the nitrate concentration in a soil rich in humus. It is shown that the nitrate concentration increases with a rise in temperature, but the actual amount remaining in the soil depends on the rainfall. The greater the rainfall the greater is the amount of nitrate washed away: a thick cover of vegetation tends to keep the nitrate concentration more constant.

On the Internal and External Factors Governing the Utilisation of Ammonia and Nitrogen by Plants. *Prjanischnikow.* (*First Part.*) *Zeit. Pf. Dung. u. Bodenk,* 1933, 30, 1/3, 38-82.—A historical account is given of nitrogen fertilization with special reference to the questions as to which form of combined nitrogen—ammonia or nitrate—is more readily assimilated by the plant. The author's own experiments on this question are outlined and emphasis is laid on the importance of external factors such as the following: Culture solution methods employed; necessity for removal of physiological acidity in comparing effects of ammonia and nitrate in culture solutions; sulphate of ammonia was found to give its optimum yield in a neutral medium, whilst the optimum yield from nitrate of soda was found in an acid medium (p. H. 5·5); poverty in calcium was found to be antagonistic to ammonia assimilation. The plants supply of carbon dioxide is one of the most important internal factors—an adequate supply favouring the utilisation of ammonia nitrogen. Ammonia nitrogen appears to favour the uptake of phosphoric acid by the plant; nitrates favour the uptake of potash. The author's experiments with ammonium nitrate indicate that this salt is physiologically acid and that under normal conditions the plant has a greater tendency to take up ammonia than nitrate. The effects of varying acidity and supply of light on the relative uptake of ammonia and nitrate are discussed.

The Calcium-Magnesium Ratio in Soils and its Relation to Crop Growth. *Moser. Jour. Amer. Soc. Agron.,* 1933, 25, 6, 365.—No correlation is found between the total, the replaceable and water soluble calcium and magnesium of the soils studied. It is shown for certain American soils that the replaceable calcium magnesium ratio has no significance for crop growth; the beneficial effect of liming is found to be due to the increase in the amount of replaceable calcium in those soils which were low in replaceable calcium at the outset.

Symptoms of Fertilizer Injury to Potatoes. *Bushnell. Jour. Amer. Soc. Agron.*, 1933, 25, 6, 397.—An account is given of the effects observed from fertilizer placed in close proximity to potato seed pieces or to small, whole seed tubers. The most common symptom is retardation of sprout growth; severe types of injury are to be expected only where large amounts of fertilizer are placed in contact with or above the seed. Cut seed is more liable to injury from an unequally distributed fertilizer than whole seed.

Absorption of Potassium by Plants in Relation to Replaceable, Non-replaceable and Soil Solution Potassium. *Hoagland and Martin. Soil Sci.*, 1933, 36, 1, 1.—A description is given of experiments which were conducted on fifteen Californian soils in order to obtain information on plant growth in relation to the supplying power of soils for potassium. Particular attention is paid to the supplying power of the soils in relation to different forms in which potassium may occur in the soil, and an outline is given of the relative importance of each of these forms in regard to plant growth.

Peat Soils and Vegetation in Scotland. *Nature. Volume* 132, *No.* 3332, 412-413.—At the instance of the Forestry Commission, the Department of Forestry of the University of Aberdeen has undertaken investigations into the establishment of timber crops on peat soils in Scotland and particularly under west coast conditions as illustrated at Inverliver on Loch Awe. Dr G. K. Fraser of the Aberdeen Department of Forestry contributes an account of these investigations in *Forestry Commission Bulletin, No.* 15, "Studies of Scottish Moorlands in relation to Tree Growth" (H.M. Stationary Office, London, 1933). Much of the peat land is of course unsuitable for agriculture, and according to present knowledge, would appear only economically utilisable for afforestation purposes. The author classifies the different kinds of peat upon a broad pedological basis, within which further divisions are made according to their structure and vegetational origin. It is held that two points emerge from the enquiry: first, that there is a lack of success in planting trees on that class of peat which is characterised by deer grass and heather (the *Scirpus* high moor type) and, second, the value of basic slag combined with methods of turf-planting. The bulletin deals with origins and development of peat; physiological features and vegetation of the western Scottish moorland region; effect of long-continued heather burning and grazing upon the moorland vegetation of west of Scotland; peat and its associated types of vegetation; soil-forming (edaphic) properties of peat; sylvicultural quality of peat soils—as assessed by the rate of tree growth; and sylvicultural improvement of peat areas.

Reaction of Soils upon Animals. *Nature. Volume* 132, *No.* 3332, 413.—The possible influences of the chemical conditions of soils upon the creatures which exist upon them have not been fully realised, and Dr Stewart MacLagan has studied the relationship in a series of selected types (*Proc. Roy. Physical Soc., Edinburgh*, 22, 107; 1933).—Indirectly, even vertebrates may be affected by the composition of the soil, since acid content is reflected in the composition of the herbage, and this may be expressed in calcium deficiency, as in "the bent-leg" disease of sheep. Earthworms and snails are most numerous in soils which are approximately neutral in reactions and a series of experiments with the primitive insect (Collembola) *Symnthurus viridis*, showed that soil reactions appreciably influenced the duration of the reproductive phase, and profoundly influenced the reproductive capacity of the insect. Since Collembola, like earthworms, swallow soil, it is suggested, from morphological and physiological evidence, that they also may have the power of modifying the "acidity" of the soil, so that they gradually create a more favourable environment for their own existence.

DAIRYING

B. Coli in Milk. *Pieu, Bachimont und Filhol. Le Lait. 13*, 817, 1933.—The authors have carried out extensive investigations on the presence of B. Coli in milk, and have shown how quantitative measurements of this organism in market milk may be arrived at. They find that pasteurisation to 149° F. for 30 minutes completely destroys B. coli, and provided that no reinfection of the milk after such heat treatment takes place, pasteurised milk should be quite free from this organism.

Rancidity in Milk. *Cseszar. Milch Forsch, 14*, 288, 1933. A rancid taste observed in certain classes of milk is due to the action of a fat-splitting enzyme. Milk of such a category inhibits bacterial growth. The kind of food supplied to the cow is apparently without influence, and yet the fault is more often observed in the milk of stall-fed cows. The enzyme is destroyed by pasteurisation (145° F. for 20 minutes).

Gas Formation in Cheese. *Hagelund, Sandberg und Barthel, Le Lait, 13,* 126 and 127, 1933.—Gas formation sometimes observed in the early stages of ripening of hard pressed cheese is due primarily to the action of organisms of the *B. ærogenes* type. The infective organisms are mostly of fæcal origin, and therefore the real remedy for this defect is the production of a clean high grade milk. The authors have shown that pasteurisation to 146° F. for 10 minutes effectively destroys these organisms; that in the case of raw milk they can be largely controlled by the use of suitable amounts of a good starter, and that this control is even more effective when saltpetre at the rate of 0·05 per cent. is added to the cheese with itself. An excessive salting of the curd tends to encourage gas formation in the cheese when the milk from which it is made is infected with organisms of the *B. ærogenes* type.

ANIMAL NUTRITION

Animal Residues, Blood Meal, Meat Meal, Carcase Meal and Whale Meal as Feedstuffs for Farm Animals. *Wo. Die tierischen Abfallstoffe Blutmehl, Fleischmehl, Tierkörpermehl und Walmehl als Futtermittel in der landw. Nutzviehhaltung. Ztschr. f. Schweinezucht,* 1933, *40,* 115-118.—A description of each of the products is given with special reference to their protein, mineral and vitamin contents. Comparative experiments are discussed in which the foods tested formed a part of a basal mixture fed with potatoes. None of the animal protein foods gave such good results as fish meal, but were better than vegetable proteins, and were not found to affect adversely the quality of the carcases produced. Their economic value depends on their prices relative to fish meal.

Feeding Value of Sugar Beet and Dried Products. *Fingerling, G. Der Nährwert der Zuckerrüben und der daraus gewonnenen Trockenerzeugnisse. Landwirtsch-Gesellsch,* 1933, *48,* 222-223. (*Res. Stat., Leipzig-Mockern.*)—The nutritive values of (*a*) dried sugar beet, fed as slices; and of (*b*) ordinary dried slices were determined in respiration experiments. In ruminants (*a*) did not give greater gain in flesh or fat, although the digestibility was higher, than (*b*). Starch equivalent was 54·7 kg. for (*a*) and 55·7 kg. for (*b*) per 100 kg. dry matter. With pigs the starch equivalent of (*a*) was 75·4 kg.

Feeding Draft Colts. *Hudson, R. S. Prox. Amer. Soc. Animal Production,* 1932 (*January* 1933), 113-115. (*Michigan State Coll. Agric.*)—Three lots of weaning, draft colts were fed (January to May), (*a*) liberally equal parts of ear corn and whole oats at the rate of 2 lb. per 100 lb. live-weight per day; (*b*) the same as (*a*) but one-half the grain, and (*c*) one-fourth the grain in (*a*) and 1 lb. alfalfa mixed hay per 100 lb. live-weight. The first two lots had constant access to hay. From May to November the animals were on pasture, and received grain as follows: (*a*) 1 lb., (*b*) ½ lb., and (*c*) no grain. The final average weights were 1197, 1137 and 1081 lb. respectively. The data include gains in weight, height, heart girth and width of chest for colts from Percheron and Belgian stallions.

Wheat—Is It Suitable Food for Dairy Cows? *Snook, L. C. Jour. Dept. Agric., W. Australia,* 1932, *9,* 530-532.—The author concludes from the evidence he reviews that wheat is a valuable food for dairy cattle, and recommends its use with certain precautions: it should be fed crushed, and should be gradually introduced into the ration and never allowed to exceed half the concentrates fed. Wheat being starchy food requires a protein supplement, and meat meal is recommended. Wheat, which is rich in phosphate and deficient in lime, should be supplemented with an additional supply of lime.

Cotton Seed for Dairy Cows. *Lush, R. H., and Gelpi, A. J. Louisiana Agric. Exp. Stat. Bull. No.* 227, 1932, 11 *pp.*—Cows fed on rations containing cotton-seed meal produced more milk and greater live-weight increase than those receiving a similar ration with whole seed. Butter from cows receiving cotton-seed was exceptionally hard, brittle and mealy, and had a tallow-like flavour. The churning period of the cream was also prolonged.

Ground Limestone for Fattening Cattle. *M'Campbell, C. W. Proc. Amer. Soc. Animal Production,* 1932 (*January* 1933), 60-62. (*Kansas State Coll.*)—Alfalfa hay, 2 lb. per day, has been found to improve a ration of corn, cotton-seed meal and corn silage for fattening cattle. Further tests in which calcium carbonate, 0·1 lb., was used in place of alfalfa hay gave equally efficient results, indicating that the most important factor in the alfalfa in such a combination of feeds is the calcium content.

Sodium Bicarbonate at Different Levels for Growing Gilts on Pasture. *Anderson, A. L., Culbertson, C. C., Evvard, J. M., and Hammong, W. E. Proc. Amer. Soc. Animal*

Production, 1932 (*January* 1933), 151-154. (*Iowa Exp. Stat.*)—An experiment with three groups of growing gilts conducted over a period of three years with three successive generations of animals demonstrated that the feeding of sodium bicarbonate in quantities of 0·0013, 0·0039 and 0·0117 lb. per gilt per day in addition to an adequate basal ration did not have any significant effect on the rate of gain or feed requirements per unit gain of the growing and developing gilts. There was, also, no indication of cumulative effect from sodium bicarbonate feeding.

Use of Silage for Fattening Pigs. *Lüthge* (*Dr*). *Die Möglichkeiten der Verwendung von Silage bei der Mast der Schweine. Ztschr. f. Schweinezucht*, 1933, *40*, 134-135. (*Halle a.S.*)—Three experiments are briefly described in which various types of silage or sugar-beet tops were fed with equal parts of potatoes to pigs receiving a basal of cereals with additional protein and minerals. Satisfactory results were obtained, especially with pigs over 35 kg. weight.

Securing Early Turkeys by Stimulated Egg Production. *Albright, W. P., and Thompson, R. B. Poultry Sci.*, 1933, *12*, 124-128. (*Oklahoma Agric. Exp. Stat., Stillwell.*)—Two groups, each containing twelve females and one male, were housed on 1st December in pens, 12 by 16 feet, with sun porches and yards attached. Morning lights were given, and a laying mash fed till 1st June. Egg production was so stimulated that the age of the first pullet to lay was only 237 days. Nine birds were culled as unsatisfactory during the period, and, of the remaining fifteen, the average egg production was 85·73 eggs, average weight of eggs 84·07 grams, average fertility 86·19 per cent., average hatchability of fertile eggs 67·32 per cent. The average food consumption per bird was 6·87 lb. of mash and 7·18 lb. of grain monthly.

" Cripples " in Lambs. *Stewart, W. L. Vet. Rec.*, 1933, *13*, 109-112. (*Armstrong Coll., Newcastle-upon-Tyne.*)—" Cripples " is a disease of lambs occurring on permanent pasture grazings. Lambs from one to two weeks old are most susceptible. Clinically the condition resembles joint ill, but sepsis is absent, and the symptoms (stiffness and bone fragility) are probably related to imperfect osteogenesis. Both the calcium and inorganic phosphorus of the body of affected lambs are sub-normal. The possible relationship of the condition to pasture mineral deficiency is discussed.

Asthenia in Piglings. *Stewart, W. L. Vet. Jour.*, 1932, *88*, 421-424. (*Armstrong Coll., Newcastle-upon-Tyne.*)—An outbreak of " asthenia " (debility, lack of strength, etc.) occurring in newly farrowed piglings in a piggery in the North of England was attributed, from the composition of the sow's milk, to deficiency of mineral matter in the sow's ration. The addition of mineral rich foodstuffs (fish meal) or a mineral mixture to the sow's ration prevented a recurrence.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS, AND FERTILISERS IN JUNE, JULY and AUGUST 1933.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	JUNE			JULY			AUGUST		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ..	45 8	41 0	39 6	45 7	41 3	39 0	45 9	41 1	38 10
Cross-bred (Shorthorn)	42 2	38 2	31 5	41 10	37 10	30 8	41 5	37 4	30 10
Galloway	42 5	38 7	..	41 1	38 7	..	39 9	36 11	32 6
Ayrshire	36 8	32 1	27 2	38 0	33 2	28 4	36 9	32 1	27 6
Blue Grey	46 0	41 0	37 6	44 11	41 0	38 8	45 2	41 0	38 0
Highland	45 6	40 0	..	..	..	..	..	..	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb d.	per lb. d.
†VEAL CALVES	12	3½	..	12	3½	..	10½	3¼	..
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes per lb. d.
Cheviot	10¼	9¾	6½	9½	9¼	6¼	9½	8¾	6¼
Half-bred	9¾	8¼	5¼	9	7¾	5¼	8¼	7	5¼
Blackface	10¾	10	6¾	9¾	9	6½	9½	8¾	6½
Greyface	10	9¼	6¼	9¼	8½	5¾	9	7¾	6
Down Cross	10¼	..	4½	9½	9	5	9½	8½	5
†PIGS—	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.
Bacon Pigs	8 0	7 5	..	7 9	7 2	..	8 0	7 4	..
Porkers	8 10	8 3	..	8 8	8 1	..	8 11	8 4	..

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK: Monthly Averages of Prices (per head) at certain representative Scottish Markets—(*continued*).

DESCRIPTION	JUNE			JULY			AUGUST		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—									
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	14 14	11 17	8 8	14 8	11 7	8 0	14 10	10 11	7 7
Two-year-olds ..	17 7	14 17	10 19	17 6	14 4	11 5	17 12	14 15	10 0
Cross-bred (Shorthorn)									
Yearlings	13 5	10 12	7 13	12 17	9 18	7 7	13 7	9 16	7 10
Two-year-olds ..	16 9	13 13	9 13	15 19	13 12	9 15	16 5	13 8	9 0
Galloway:									
Yearlings	12 10	10 0	..	11 9	9 0	..	11 9	8 18	..
Two-year-olds ..	18 5	15 5	..	..	..	..	..	14 15	..
Ayrshire:									
Yearlings	10 9	9 8	7 15	11 4	10 0	9 0	..	..	..
Two-year-olds ..	13 16	11 2	9 15	14 6	12 0	10 0	12 0	10 0	8 0
Blue Grey:									
Yearlings	..	..	..	..	..	..	..	..	..
Two-year-olds ..	19 10	..	..	..	..	..	..	..	..
Highland:									
Yearlings	10 0	7 15	5 13	..	6 8	..	..	..	..
Two-year-olds ..	12 3	10 5	8 5	..	9 10	..	..	..	..
Three-year-olds ..	..	12 18	11 10	..	..	..	..	..	..
DAIRY COWS—									
Ayrshire:									
In milk	23 12	17 12	12 10	25 8	19 5	13 4	25 8	18 18	14 0
Calvers	24 7	18 6	13 3	24 19	19 11	14 2	25 0	19 16	14 17
Shorthorn Cross:									
In milk	25 0	17 6	15 5	27 3	19 17	17 5	26 13	19 18	17 15
Calvers	24 0	17 10	14 12	25 1	18 8	16 4	25 19	18 8	16 9
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ..	33 6	18 11	..	29 0	22 0	..	..	..	..
Half-bred Hoggs ..	28 7	22 0	..	30 2	21 8	..	..	..	..
Blackface Hoggs ..	27 6	21 10	13 9	..	..	..	..	..	..
Greyface Hoggs ..	32 4	28 1	22 3	29 11	23 1	..	..	..	..
Down Cross Hoggs	..	..	..	..	..	..	..	..	..
PIGS—									
(6 to 10 weeks old)	31 7	19 0	..	28 8	18 0	..	27 10	17 10	..

DEAD MEAT: Monthly Average Prices (per lb.) at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	JUNE			JULY			AUGUST		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
BEEF:—										
Home-fed—		*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*
Bullock or Heifer ..	1	7⅝	7⅛	8¼	7½	6⅞	8¼	7⅛	6⅝	8⅜
	2	6¾	..	8	6⅝	..	7⅛	6½	..	7⅜
Bull	1	5¾	5⅝	6	5¾	5⅝	5¾	5¾	5	5¾
	2	5	5	5⅜	5	5	5	5	..	5
Cow	1	4⅞	4⅞	5¼	4⅝	4¾	5	4½	4⅜	5
	2	4⅜	..	4¼	4⅛	..	4	4	..	4
Irish—										
Bullock or Heifer ..	1	..	..	7¼	..	..	..	..	..	7
	2	..	..	6½	..	..	..	..	..	6⅛
Argentine Frozen—										
Hind Quarters ..	1	4	3⅝	..	4⅜	3⅜	..	4	3¾	..
	2	..	3	..	..	3	..	..	2⅞	..
Fore „ ..	1	3⅜	3⅜	..	3⅜	3¼	..	3¼	3¼	..
	2	..	2¾	..	..	2¾	..	..	2¾	..
Argentine Chilled—										
Hind Quarters ..	1	6⅛	5⅞	5½	6¼	6⅛	5½	6¼	6¼	5¾
	2	..	5¼	4⅞	..	4	4⅝	..	5⅜	5
Fore „ ..	1	3⅜	3⅜	2⅞	3⅝	3⅛	2⅞	3⅝	3½	3¼
	2	..	2¾	2¾	..	2⅝	2¾	..	3	3
Australian Frozen—										
Hind Quarters ..	1	..	..	3⅛	..	..	3⅛	..	..	3¼
	2	..	..	..	..	..	..	..	..	..
Crops	1	..	..	2¾	..	..	2¾	..	..	2⅞
	2	..	..	..	..	..	..	..	..	..
New Zealand Frozen—										
Hind Quarters ..	1	..	..	3⅛	..	..	3⅛	..	..	3⅛
	2	..	..	..	..	..	..	..	..	..
Fore „ ..	1	..	..	2½	..	..	2½	..	..	2⅝
	2	..	..	..	..	..	..	..	..	..
MUTTON:—										
Hoggs, Blackface ..	under 60 lb.	11	11	10¾	10¾	10	9⅜	10⅜	8⅜	8½
	60 lb. & over	10	..	9⅞	10	..	8⅜	9⅞	..	7⅞
„ Cross ..	under 60 lb.	11	11	10¾	10¾	10	9⅜	10⅜	8⅜	8½
	60 lb. & over	10	..	9⅞	10	..	8⅜	9⅞	..	7⅞
Ewes, Cheviot ..	1	..	6¾	7½	..	6⅜	6⅞	..	5	6⅜
	2	..	..	6⅞	..	..	6⅜	..	..	5¾
„ Blackface ..	1	8	6¾	7½	7¾	6⅜	6⅞	7⅜	5	6⅜
	2	7½	..	6⅞	7¼	..	6⅜	6⅞	..	5¾
„ Cross	1	6	6¾	7½	6	6⅜	6⅞	5¾	5	6⅜
	2	5	..	6⅞	5	..	6⅜	4⅞	..	5¾
Argentine Frozen ..	1	..	..	3½	..	..	3½	..	..	3½
	2	..	..	..	..	..	..	..	..	..
Australian „ ..	1	..	4⅜	3½	..	4½	3½	..	4½	3½
	2	..	3⅝	..	..	3⅝	..	..	3¾	..
New Zealand „ ..	1	..	..	3½	..	..	3½	..	..	3⅝
	2	..	..	3¼	..	..	3¼	..	..	3¼
LAMB:—										
Home fed	1	..	12⅛	12¼	11	10¾	10⅜	10½	9⅝	9¾
	2	..	..	11¼	..	..	9⅞	..	..	9⅛
New Zealand Frozen	1	..	7⅜	6⅝	..	7⅜	7¼	..	7¼	7⅛
	2	..	6½	6⅜	..	6⅛	6¾	..	6¼	6⅝
Australian „ ..	1	..	..	6	..	..	6½	..	..	6½
	2	..	..	5⅜	..	..	..	..	..	..
Argentine „ ..	1	..	..	5⅛	..	..	5¾	..	..	5⅞
	2	..	..	4⅞	..	..	5	..	..	..

EGGS : Monthly Average Wholesale Prices at Aberdeen, Glasgow, Kilmarnock and Lanarkshire.

DESCRIPTION	QUALITY	JUNE	JULY	AUGUST
		s. d.	s. d.	s. d.
ABERDEEN—				
Country .. .. per doz.	1	0 9¼	1 0	1 1
	2	0 8¾	0 11	1 0
Duck .. .. ,,	1	0 9½	1 1	1 2
GLASGOW—				
Country .. .. per doz.	1	1 0	1 3	1 5
	2	0 11	1 1	1 4
Irish—				
Northern Ireland per 120	1	10 11	12 1	14 5
	2	9 11	11 2	13 0
,, (Duck) ,,	1	7 9	8 3	10 6
Free State .. ,,	1	8 10	9 11	12 1
	2	8 4	9 4	11 7
,, (Duck) ,,	1	7 3	7 9	9 11
Danish .. .. ,,	1	8 10	8 8	11 5
	2	..	..	11 0
Polish .. .. ,,	1	6 4	6 4	6 7
	2	6 0	5 5	6 0
Norwegian .. ,,	1	8 5	..	..
KILMARNOCK—				
Country .. .. per doz.	1	0 11	1 3	1 4
LANARKSHIRE—				
Country (Standard) ,,	1	..	1 3	1 6

PROVISIONS : Monthly Average Wholesale Prices (per cwt.) at Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	JUNE	JULY	AUGUST
		s. d.	s. d.	s. d.
BUTTER—				
Irish Creamery	1	86 0	84 9	92 10
,, (unsalted)	1	90 6	88 9	96 5
Australian	1	85 6	85 3	89 0
,, (unsalted)	1	89 6	89 3	93 0
Danish	1	96 0	99 9	109 10
,, (unsalted)	1	99 0	102 9	113 2
New Zealand	1	86 0	84 9	94 10
,, (unsalted)	1	90 0	88 9	97 7
Swedish	1	91 6	93 9	96 10
CHEESE—Cheddar	1	78 0	78 0	78 0
Cheddar Loaf	1	79 0	79 0	71 10
Dunlop	1	64 0	64 0	64 10
Canadian	1	76 0	76 0	66 10
New Zealand (Coloured) ..	1	56 9	54 6	56 0
,, (White)	1	54 0	53 3	55 7
HAMS—Irish (Smoked)	1	157 0	174 6	182 0
	2	147 0	164 6	172 0
American (Long Cut, Green) ..	1	88 0	87 0	80 7
,, (Short Cut)	1	87 0	84 9	80 10
Canadian (Long Cut)	1	90 0	88 0	83 0
BACON—Ayrshire (Rolled, Scotch Pork)	1	103 6	102 0	112 0
English Wiltshire (Green) ..	1	94 6	93 9	104 2
,, (Dried or Smoked) ..	1	99 6	98 9	110 7
Irish (Green)	1	87 6	87 9	103 2
,, (Dried or Smoked) ..	1	93 0	93 6	108 10
,, (Long Clear)	1	95 6	97 6	110 2
Canadian Sides	1	65 0	65 3	77 10
Danish Sides	1	79 0	81 0	89 7
Dutch (Green, Wiltshire Style)	1	89 0	90 3	104 0
Polish (,, ,, ,,)	1	78 0	83 6	93 2
LARD—				
American	1	50 6	46 6	44 2

FRUIT AND VEGETABLES : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter)

DESCRIPTION		QUALITY	JUNE	JULY	AUGUST
			s. d.	*s. d.*	*s. d.*
FRUIT :—					
Apples, British—	per				
Lord Derby	barrel.*	1	..	..	8 0
Other Cooking	,,	1	..	10 0	9 1
American	case.†	1	..	..	13 2
Australian	,,	1	9 5	..	..
New Zealand	,,	1	10 2	9 7	9 5
Pears, Australian ..	,,	1	14 4	14 0	..
Cherries, British ..	lb.	1	0 8	..	..
,, Imported ..	,,	1	0 8	0 8	..
Blackberries	,,	1	..	..	0 6
Currants, Black	,,	1	0 9	0 8¼	0 8½
,, Red	,,	1	0 8	0 6½	0 6
Damsons	,,	1	..	..	0 3¾
Gooseberries, British ..	,,	1	0 2¾	0 2	0 2
,, Imported	,,	1	0 3	0 1½	..
Greengages, British ..	,,	1	..	..	0 5¼
,, Imported ..	,,	1	..	0 7¼	0 7
Plums, Victoria	,,	1	..	..	0 4
,, Monarch ..	,,	1	..	..	0 2¼
,, Czar	,,	1	..	0 2	0 2½
,, Egg	,,	1	..	0 2	0 2
,, Early River ..	,,	1	..	0 3	0 2¼
,, Italian, Cherry ..	,,	1	0 5	..	..
Raspberries	,,	1	0 10	0 6½	0 8
Strawberries, Scottish ..	,,	1	0 8	0 10¾	1 0
,, English ..	,,	1	0 8½	0 8	..
,, Imported	,,	1	0 10	0 6	..
VEGETABLES :—					
Beans, Dwarf	,,	1	..	0 4¼	0 3
Beet	cwt.	1	5 0	6 0	5 5
Brussels Sprouts ..	net‡	1	..	..	4 9
Cabbage, Scottish ..	dozen.	1	1 9	1 9	1 4
,, Coleworts ..	,,	1	1 0	1 0	1 0
,, Red	,,	1	2 6	..	2 7
Carrots, British	cwt.	1	5 8	15 0	11 5
,, Dutch ..	dozen bunches.	1	3 11	3 10	§9 11
Cauliflowers, British ..	dozen.	1	4 8	4 0	3 8
,, Dutch ..	,,	1	3 0	..	..
Celery	bunch.	1	..	..	2 6
Cucumbers	dozen.	1	5 6	5 0	5 0
Leeks	dozen bunches.	1	..	7 0	3 5
Lettuce, Cos	dozen.	1	1 4	1 3	1 4
,, Cabbage ..	,,	1	1 5	1 3	1 4
Onions, *Spring*	bunch.	1	0 5	0 4¼	0 3¾
,, *Egyptian* ..	cwt.	1	5 9	5 3	5 0
,, *Dutch*	bag.**	1	..	6 6	6 2
,, *Valencia* ..	case.††	1	7 0	7 6	8 0
Parsley	cwt.	1	12 0	24 0	13 7
Peas (Home-grown) ..	,,	1	‖7 8	13 0	15 6
Radishes	dozen bunches.	1	1 4	1 5	1 4
Rhubarb	cwt.	1	2 6	3 8	3 0
Spinach	stone.	1	3 9	3 0	2 10
Tomatoes, *Scottish National*					
Mark "A.A."	lb.	1	0 8¾	0 5½	0 5¼
Other Scottish	,,	1	0 8¼	0 5	0 4¾
Channel Islands ..	,,	1	0 7½	0 4¾	0 4
Dutch	,,	1	0 6¾	0 4½	0 4
Turnips	dozen bunches.	1	3 5	4 2	§3 7
Vegetable Marrow ..	dozen.	1	..	..	3 5

* 56 lb. (approx.). ** 7½ stone (approx.). § per cwt. † 40 lb. (approx.).
†† 9 stone (approx.). ‖ per pot (40 lb.). ‡ 20 lb (approx.).

POTATOES : Monthly Average Wholesale Prices per ton at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	FIRST EARLIES	SECOND EARLIES	LATE VARIETIES: RED SOILS: Golden Wonder	LATE VARIETIES: RED SOILS: Other	LATE VARIETIES: OTHER SOILS: Golden Wonder	LATE VARIETIES: OTHER SOILS: Other
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
		JUNE					
Aberdeen ..	1	..	..	..	..	2 6 3	1 18 9
Dundee ..	1	7 0 0	..	..	..	2 10 0	2 0 0
Edinburgh ..	1	10 10 0	..	..	..	..	2 0 0
Glasgow ..	1	10 0 0	..	..	..	2 8 9	1 11 3
		JULY					
Aberdeen ..	1	5 13 4	..	..	..	1 12 6	1 10 0
Dundee ..	1	5 8 9	..	..	..	2 10 0	..
Edinburgh ..	1	4 18 2	..	..	..	..	..
Glasgow ..	1	4 10 0	..	..	..	1 12 6	1 10 0
		AUGUST					
Aberdeen ..	1	4 2 6	2 17 6	..	..	..	..
Dundee ..	1	4 5 0	3 1 8	..	..	..	..
Edinburgh ..	1	2 17 6	2 11 8	..	..	..	..
Glasgow ..	1	2 18 9	2 17 6	..	..	..	2 17 6

ROOTS, HAY, STRAW, AND MOSS LITTER : Monthly Average Prices per ton at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	ROOTS: Carrots	ROOTS: Yellow Turnips	ROOTS: Swedes	HAY: Rye Grass and Clover	HAY: Timothy	STRAW: Wheat	STRAW: Barley	STRAW: Oat	MOSS LITTER
		s. d.	s. d.	s. d	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
		JUNE								
*Aberdeen ..	1	..	..	..	50 0	..	..	..	26 3	..
†Dundee ..	1	..	..	..	70 0 60 0*b*	..	50 0	..	50 0	50 0*c*
‖Edinburgh ..	1	..	..	..	60 0*a* 55 0*b*	..	25 0	..	25 0	..
*a*Glasgow ..	1	..	..	..	55 0	60 0	35 0	..	32 6	31 3*d*
		JULY								
*Aberdeen ..	1	..	..	..	48 9	..	..	..	25 0	..
†Dundee ..	1	..	..	..	70 0 60 0*b*	..	50 0	..	50 0	50 0*c*
‖Edinburgh ..	1	..	..	..	60 0*a* 53 9*b*	..	25 2	..	25 2	..
*a*Glasgow ..	1	..	..	..	55 0	60 0	35 0	..	33 9	31 3*d*
		AUGUST								
*Aberdeen ..	1	..	..	..	50 0	..	..	..	25 0	..
†Dundee ..	1	..	..	..	70 0 60 0*b*	..	50 0	40 0	50 0	50 0*c*
‖Edinburgh ..	1	..	..	..	55 0*b*	..	37 0	..	37 0	..
*a*Glasgow ..	1	..	..	..	55 0	60 0	35 0	..	35 0	31 3*d*

* Ex-farm, loose. ‖ Bunched straw, delivered. *b* Delivered, loose.

† Baled and delivered in town. *a* Baled and delivered. *c* Dutch moss litter, at quay.

d Home moss litter, in 1½-cwt. bales.

FEEDING STUFFS: Monthly Average Prices per ton at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	JUNE		JULY		AUGUST	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
Linseed Cake—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Home	8 7 6	8 5 0	8 6 11	8 5 0	8 8 3	8 5 0
Foreign	7 19 5	..	8 1 7	7 17 6	8 0 9	8 0 0
Decort. Cotton Cake ..	7 6 3	..	7 7 6	..	7 7 3	..
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	6 0 0	5 17 6	5 11 3	5 5 0	5 4 0	5 1 6
Bombay (Home manufactured)	..	5 6 11	..	4 15 0	..	4 15 0
Palmnut Kernel Cake ..	7 5 0	..	7 5 0	..	7 5 0	..
Soya Bean Cake	8 5 0	..	8 0 0	..	7 15 0	..
Coconut Cake	7 12 6	..	7 12 6	..	7 12 6	..
Groundnut Cake, undecort.—						
(37 % Oil and Album.)	..	6 9 5	..	6 9 5	..	6 6 6
(40 % ,, ,,)..	..	7 0 0	..	7 1 11	..	7 2 6
Maize Germ Cake, Home mfd.	6 15 8	..	6 16 3	..	6 12 0	..
Maize Germ Meal	5 5 11	..	5 10 0	..	5 12 0	..
Rice Meal	4 8 2	4 10 0	4 3 9	4 10 0	4 5 0	4 10 0
Bean Meal	6 18 9	7 17 6	7 8 2	7 10 8	7 8 0	7 7 0
Barley Meal	6 18 5	6 15 8	7 2 2	6 15 8	7 3 9	6 15 0
Fish Meal	13 17 6	14 0 0	13 18 9	13 17 6	14 5 0	14 5 0
Maize Meal—						
Home manufactured ..	5 10 8	5 10 8	5 14 5	5 6 11	5 14 6	5 11 6
South African (Yellow) ..	5 9 1	5 7 6	5 12 2	..	5 11 6	..
,, ,, (White) ..	5 10 0	..	..	..	..	..
Locust Bean Meal	6 15 0	5 17 6	6 15 0	5 19 5	6 16 6	6 4 0
Maize Gluten Feed (Paisley)	5 5 0	..	5 5 0	..	5 14 6	..
Maize—Plate	4 10 8	4 14 5	4 16 11	4 11 11	4 14 0	4 11 6
African	4 14 8	..	..	..	6 3 2	..
,, (White Flat) ..	5 2 6	..	5 6 11	..	5 15 6	..
Oats—						
Home	5 15 0	5 12 6	5 13 2	5 15 0	5 12 0	5 14 0
Plate	5 10 0	5 7 6	5 10 8	5 11 3	5 11 0	5 10 0
Barley—						
Home	6 10 0	6 5 8	6 11 3	6 2 6	6 16 6	6 0 0
Imported	5 16 7	..	6 2 6	..	6 8 2	5 5 0
Wheat—						
Home	6 13 9	6 6 3	7 9 8	7 5 0	7 6 3	6 14 0
,, (Poultry)	6 10 11	..	7 8 9	..	7 5 9	..
Imported	6 14 5	6 2 6	7 8 2	6 16 3	7 2 0	6 7 0
Middlings (Fine Thirds or Parings)	5 13 5	5 7 6	6 0 0	5 8 9	5 16 0	5 14 0
Sharps (Common Thirds)	4 14 5	4 12 6	4 18 9	4 14 5	4 16 3	4 19 6
Bran (Medium)	4 9 8	4 10 0	4 17 2	4 16 11	4 14 3	4 17 0
,, (Broad)	4 10 10	5 5 0	4 18 5	5 11 11	5 1 0	5 12 0
Malt Culms	4 15 8	4 7 6	4 15 0	4 7 6	4 14 9	4 9 0
Distillers' Mixed Grains (Dried)	..	6 16 3	..	6 8 9	6 7 6	6 5 0
Distillers' Malt Grains (Dried)	6 12 6	..	6 5 0	..	6 10 0	..
Brewers' Grains (Dried) ..	5 15 8	4 17 6	5 6 11	4 11 11	5 7 9	4 11 6
Crushed Linseed	13 10 0	..	14 10 0	..	15 6 0	..
Locust Beans (Kibbled and Stoned)	5 16 3	5 15 8	5 18 5	5 17 6	5 19 0	5 19 6
Beans—						
China	5 18 9	..	6 9 1	..	6 12 6	..
English	6 5 8	..	6 11 3	..	6 12 6	..
Egyptian	5 17 6	..	6 8 2	6 15 0	6 8 9	6 11 8
Rangoon (White) ..	5 10 0	5 10 0	..	5 9 0	5 10 8	5 10 0
,, (Red)	..	..	..	5 9 0	..	5 10 0
Pease—						
Calcutta (White)	10 0 0	..	..	..	9 15 0	..
Karachi (,,)	9 16 8	..	..	..	..	..
Baltic (,,)	..	..	..	8 0 0	..	6 15 0
Feeding Treacle	4 17 6	5 8 9	4 15 0	5 5 0	4 15 0	5 5 0
Sugar-Beet Pulp	..	..	..	4 6 8	..	4 10 0
Linseed Oil, per gall. ..	0 3 6	..	0 3 9	..	0 3 6	..

FERTILISERS: Monthly Average Prices per ton at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	JUNE		JULY		AUGUST	
		Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Nitrate of Soda *	N. 15·5	8 16 0	8 16 0	8 16 0	8 16 0	7 19 6	8 5 0
Sulphate of Ammonia (Neutral and Granular) * ..	N. 20·6	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 15 0
Calcium Cyanamide †	N. 20·6	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
Nitrochalk * ..	N. 15·5	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0
Superphosphate ..	P.A. 13·7	2 12 6	2 12 6	..	..	2 12 6	2 12 6
„ ..	„ 16·0	2 17 6	2 17 6	..	..	2 17 6	2 17 6
„ ..	„ 18·3	3 2 6	3 2 6	..	..	3 2 6	3 2 6
Ground Mineral Phosphate ** ..	P.A. 26	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6	2 7 6
„ „ „ ** ..	„ 34	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Potassic Mineral Phosphate	P.A. 18 Pot. 10	3 16 3	..	3 16 3	..	3 16 3	..
„ „ „	P.A. 20 Pot. 7·5	3 10 0	..	3 10 0	..	3 10 0	..
„ „ „	P.A. 21 Pot. 5	..	..	..	..	3 5 0	..
Kainit (in Bags) ..	Pot. 14	3 12 6	3 5 0	..	..	..	..
Potash Salts ..	Pot. 20	4 5 0	..	..	..	..	..
„ „ ..	„ 30	5 15 0	5 5 0	..	..	..	..
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	10 2 6	9 15 0	..	..	..	..
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	12 0 0	11 12 6	..	..	..	..
Steamed Bone Flour	N. 0·8 P.A. 28	6 0 0	..	6 0 0	..	6 0 0	..
„ „	N. 1 P.A. 60	..	5 10 0	..	5 10 0	..	5 12 0
Bone Meal (Indian)	N. 4 P.A. 20	7 0 0	..	6 17 6	..	6 15 0	..
„ „ „	N. 4 P.A. 45	..	7 5 0	..	7 5 0	..	7 5 0
Potassic Slag	P.A. 12 Pot. 6	..	3 10 0	..	..	..	..
Basic Slag ‡ ..	P.A. 12	..	..	2 5 0	..	2 5 0	..
„ „ ..	„ 13	..	1 17 6	2 6 0	..	2 6 0	..
„ „ ..	„ 14	..	1 19 6	2 8 0	..	2 8 0	..
„ „ ..	„ 15	..	2 1 6	..	..	..	..

Abbreviations:—N. = Nitrogen; P.A. = Phosphoric Acid; Pot. = Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

** Fine grist, 90 per cent. fineness through prescribed sieve.

‡ Basic Slag:—At Glasgow—80 per cent. citric soluble and 80 per cent. fineness; F.o.r., in 6-ton lots. At Leith—Prices 6d. per ton higher, if carriage paid to Border Stations.

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